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A HANDBOOK ON RADIOSOUNDING OF THE ATMOSPHERE FOR ARCTIC AEROLOGICAL STATIONS

A. A. Girs

The following pages contain a translation of the book "A Handbook on Radiosounding of the Atmosphere for Arctic Aerological Stations" (Rukovodstvo po Radiozondirovaniyu Atmosfery dlya Aerologicheskikh Stantsiy Arktiki, A. A. Girs, Izdatel'stvo Glavsevmorputi, Moscow-Leningrad, 1946). The contents of the present document are:

TABLE OF CONTENTS

Page

A.	List of Publications on Hydrometeorological Observations in Arctic	
B.	Preface	
C.	Foreword	
D.	Chapter I - The Comb Radiosonde	
	1. Construction and Operation of the Instrument	
	2. The Radiosonde Transmitter	
	3. The Transmitter Power Supply	
E.	Chapter II of Equipment of a First-Class Arctic Aerological Station	
	1. The Aerological Laboratory	
	2. The Aerological Pavilion	
	3. Equipment of the Place Where Radiosondes are Checked and Launched	
F.	Chapter III - Preparation for Launching, Launching, and Reception of Radiosonde Signals	
G.	Chapter IV - Processing Radiosonde Signals	

CONFIDENTIAL

- 1 -

CONFIDENTIAL

A. THE SERIES OF HANDBOOKS, MANUALS, AND INSTRUCTIONS FOR THE PRODUCTION AND PROCESSING OF HYDROMETEOROLOGICAL OBSERVATIONS FOR ARCTIC STATIONS AND EXPEDITIONS OF THE MAIN ADMINISTRATION OF THE NORTHERN SEA ROUTE

1. A. V. Biarki, Manual on Processing Meteorological Observations of Arctic Stations, 1944.
2. A. A. Girs, T. V. Nikolayeva, Manual on the Production and Processing of Aerological Observations in Arctic Stations, 1944.
3. N. I. Shimko, Tables and Nomograms Used in Processing Aerological Observations, 1944.
4. K. A. Gomoyunov, Instructions for the Production of Observations on Temperature, Salinity, Transparency, and Color of Sea Water, 1944.
5. K. A. Gomoyunov, Instructions for Production of Observations on the Specific Gravity of Sea Water, 1944.
6. A. P. Noskov, Instructions on the Production of Observations on Sea Level Variations at Arctic Stations, 1944.
7. S. V. Bruyevich and S. K. Demenchenok, Instructions on Chemical Tests of Sea Water, 1944.
8. A. N. Petrichenko, Instructions for Production of Observations on Ices at Arctic Stations, 1944.
9. Ya. Ya. Gakkel', Instructions for Production of Observations on Ice Flows From Ships, 1944.
10. V. S. Bol'shakov, Instructions for Measuring the Depth of the Sea and for Collection of Samples from the Ocean Bottom, 1944.
11. N. P. Georgiyevskiy, Instructions for Setting Up Datum Marks at Arctic Stations, 1944.
12. A. N. Snesov, Instructions on Instrumental Determination of the Speed and Direction of Ice Drifts from Shore, 1944.

CONFIDENTIAL

- 2 -

CONFIDENTIAL
CONFIDENTIAL

13. S. A. Romyslovskaya, Instructions on Leveling and Water-Passing (Vatopasovska) at Arctic Stations, 1944.
14. V. S. Bol'shakov, Instructions for Production of Observations on Sea Swells From Shore, 1945.
15. L. F. Titov, Instructions on the Production of Observations on Wave Agitation in the Open Sea, the Behavior of Ships on Waves, and Their Drift Under the Influence of Wind and Waves, 1946.

END

CONFIDENTIAL

CONFIDENTIAL

- 3 -

CONFIDENTIAL**CONFIDENTIAL****PREFACE**

This manual differs from the one published in 1944 (Manual for the Production and Processing of Aerological Observations at Arctic Stations) in that it is especially intended for aerological stations of a higher category, i.e., aerological observatories where daily radiosondes are made, since there was not enough information for such stations in the 1944 handbook.

The author of this manual, A. A. Girs, Candidate of Geographical Sciences, was sent to one of the polar stations to make a series of studies on the production of aerological observations (the release of radiosondes in strong winds and snowstorms, methods of generating hydrogen, etc.). The results of his work as well as the work of other aerologists have been used in this manual. Because of the special conditions which the radiosonde specialist encounters at Arctic stations, he must install and maintain the radio units himself, and a special section on basic radio engineering principles is therefore included in this manual.

The manual was edited by S. E. Sokolov, Senior Engineer of the Aerological Observatory at Sel'tsa (near Leningrad), who was instrumental in preventing possible variations from the method of producing and processing radiosonde observations used in the Hydrometeorological Service and the Main Administration of the Northern Sea Route.

In this manual, we have been able to generalize 15 years experience of polar aerologists in the Arctic aerological network. However, polar aerologists should continue to make improvements in their work and to report their suggestions to the Arctic Institute with detailed descriptions and sketches so that these suggestions can be included in later issues of the Manual and disseminated to other Arctic stations.

We hope that this manual will be favorably received and that criticism will result in the correction of unavoidable errors.

Ye. I. Tikhomirov

CONFIDENTIAL
CONFIDENTIAL

- 4 -

CONFIDENTIAL**CONFIDENTIAL**FOREWORD

The following characteristics of the Arctic are of special importance in the production of aerological observations: remoteness from the main centers of the country, high frequency of strong winds and storms, and the Arctic night. These characteristics determine the methods of producing aerological observations at Arctic stations.

Thus, the remoteness of Arctic aerological stations make the delivery of hydrogen in balloons to the Arctic almost impossible. This made necessary construction of the Bushev gas-generator, fitted for Arctic conditions, and the development of a gas-generation method. Ten years experience of polar aerologists has revealed a number of defects in the Bushev gas-generator and methodological deficiencies in the gas-generation process.

The high frequency of strong winds and storms prevented fulfillment of the program for daily radiosondes. Days with strong winds and storms were usually missed. At the same time, fronts often passed over stations on such days, and it is very necessary to have aerological observational data for the study of these fronts, in addition to the operational value of this data. It was therefore imperative to develop and test, under Arctic conditions, methods of launching radiosondes even in strong winds.

Launching of radiosondes and observations on them with theodolites is made considerably more difficult during the Arctic night. Special equipment was required for aerological observations posts, aerological pavilions, aerological laboratories, and for signalling and communication. It was therefore imperative to put into practice and check under Arctic conditions a plan for the most efficient equipping of a first-class aerological station, in order that the results might be used in other Arctic stations.

Finally, the aerologist coming to the Arctic meets slightly different working conditions and modes of life than the aerologist in more southerly

CONFIDENTIAL**CONFIDENTIAL**

- 5 -

CONFIDENTIAL

CONFIDENTIAL

latitudes. There is no radioman on the staff of aerologists at Arctic stations (making daily radiosondes) and thus the polar aerologist must install the KUB-4 receiver, locate and repair breakdowns in the receiver, interchange power packs (storage batteries, dry cells, etc), establish communications between points, maintain telephone equipment, etc. In solving the problems confronting him, the polar aerologist cannot turn to a voluminous and complex specialized course. This makes it necessary to determine that minimum of knowledge from various branches of science which is necessary for independent work in the Arctic, and to include this minimum of reference material in the manual so that the aerologist can find the solution to his problems easily and quickly.

The development of the problems referred to above was the subject-matter of a paper "Methods for Aerological Observations in the Arctic", which was written by the author while at Bukhta Tiksi (1943-44) on an assignment for the Arctic Institute. Aerologists of the Bukhta Tiksi and other polar stations took part in the preparation of this paper. The results of that work are used extensively in this manual.

Very little space was allotted to radiosonde methods in the 1944 manual. We were not able to discuss the problems referred to above in detail because this would have required special studies.

In emphasizing the problem of equipping a first-class aerological station in the Arctic in this manual, we include quite detailed sections on the description of the radiosonde, its preparation for launching, and the reception and processing of signals. The sections on preparation and processing are organized so that the paragraph headings indicate the sequence of operations, while the contents of each paragraph give directions to be followed in carrying out the given operation.

CONFIDENTIAL

CONFIDENTIAL

- 6 -

CONFIDENTIAL
CONFIDENTIAL

In describing the preparation, verification, and processing, we complied with the allowances and requirements accepted in the Hydrometeorological Service of the USSR, which are set forth in "A Manual for Producing Atmospheric Soundings With the Help of Radiosondes and Aerographs".

L. G. Makhotkin, O. V. Gudovana, and N. F. Zhirkov, aerologists of the Bukhta Tiksi polar station, aided in the compilation of this manual. V. Ye. Blagodarov, senior aerologist, participated directly in the preparation of the sections on gas-generation and switchboards. Engineers F. Ya. Zaborshchikov and G. N. Yegorov, and K. I. Vil'pert, technical director of the Bukhta Tiksi radio station, were of great assistance. The director of the work, Professor Ye. I. Tikhomirov, also aided in the compilation.

A. A. Girs

CONFIDENTIAL**CONFIDENTIAL**

- 7 -

CONFIDENTIAL**CONFIDENTIAL****CHAPTER I - CONSTRUCTION AND OPERATION OF PROFESSOR P. A. MOLCHANOV'S "COMB" RADIOSONDE SYSTEM**

Radiosonde, like ordinary meteorographs, measured the temperature, pressure, and humidity of the air in the levels through which it passes during its ascent. It differs from other methods in that the data on the elements is transmitted by radio and can be received during ascent of the instrument with a radio receiver. While the signals are being received, the balloon can be tracked with a theodolite to obtain the distribution of the wind with respect to height until the balloon ascends into the clouds. Then, by direction finding on the radiosonde, data can be obtained on the wind distribution above the cloud layers.

Professor P. A. Molchanov's comb radiosonde is employed in the USSR. The first Soviet radiosonde of this type, which proved to be the first in the world, was sent aloft on January 30, 1930 in Pavlovsk. The instrument has since undergone many design changes and is now quite accurate and reliable.

The radiosonde unit includes the instrument (in a box), an additional shield to protect the elements from solar radiation, a propellor, an offset (an extension for the counterpoise), a one-tube transmitter, two plate batteries and one filament battery, the antenna, and the counterpoise.

A. Construction and Principle of Operation

The instrument (Figs. 1 and 2) has the following main parts: duraluminum housing (40), channel frame (35), temperature element (28), temperature comb (31), pressure element (2), pressure comb (38), humidity element (1), humidity commutator (39) and comb, and the temperature and pressure commutator.

A detailed description of the separate parts of the instrument follows.

1. The instrument is mounted on an L-shaped duraluminum housing (40).

To the vertical surface of this frame is attached a U-shaped channel frame (35),

CONFIDENTIAL**CONFIDENTIAL**

- 8 -

CONFIDENTIAL

- 8 -

CONFIDENTIAL

Fig. 1 - Diagram of the Comb Rasonde (Viewed From
the Side of the Temperature Comb and Humidity Com-
mutator)

CONFIDENTIAL

CONFIDENTIAL

- 7 -
CONFIDENTIAL

- 7 -
CONFIDENTIAL

Fig. 2 - Diagram of the Comb Rasonde (Viewed
From the Side of the Pressure Comb and Humidity
Comb)

CONFIDENTIAL

CONFIDENTIAL

- 10 -

CONFIDENTIAL**CONFIDENTIAL**

which supports the temperature and pressure combs, the humidity commutator and comb, contact strips (32), and the commutator with sprocket gears, and also bearings for the rotating shafts of the contact arms. The channel frame is reinforced by a V-shaped duraluminum angle bracket (27) fastened to the horizontal surface of the main housing (40).

The outside vertical surface of the main housing supports a special bracket (41), on which the pressure and temperature elements are mounted. The bracket passes through the main housing and is fastened to the channel frame (42). This vertical surface also supports two arms (43) which pass through the main housing from the channel frame; the humidity element (a strand of hair) is fastened on these arms.

Since all elements are outside the housing, they are provided with a good air flow when the instrument is in vertical motion. The speed of the air-flow past the element averages 5 to 6 meters per second (for ascents with balloons No 50 or 100).

2. A bent bimetallic plate consisting of two welded metal strips with different coefficients of thermal expansion, serves as the temperature element. The metal with the higher coefficient is placed on the outside, and the metal with the lower coefficient on the inside. This causes the plate to bend as the temperature rises, and to straighten out as the temperature drops. One end of the plate is firmly connected to bracket (41) and the other is soldered to a bar (11), which is connected by means of a rod (44) and a sensitivity arm (45) to the contact arm (4) which moves along the temperature comb with a change in temperature.

The rod (44) is connected with the bar (11) and sensitivity arm (45) so that all can swing. The shaft (12) of the sensitivity arm rotates in bearings (46) which are mounted on the channel frame. Consequently, the plate bends and the contact arm (40) moves upward along the comb when the temperature increases and downward along the comb when the temperature drops.

CONFIDENTIAL
CONFIDENTIAL

- 11 -

CONFIDENTIAL**CONFIDENTIAL**

The amount of movement of the temperature contact arm along the comb for a one-degree temperature change is called the sensitivity of the temperature element. In calibrating the temperature element, however, another quantity, the inverse sensitivity, i.e., the amount of temperature change necessary in order to move the contact arm one tooth along the comb is usually used (for convenience in processing signals). This amount is designated dt for calibration purposes (the value of dt usually ranges from 1.2 to 1.8).

There are special holes on the arm (45) and the bar (11) for the sensitivity adjustment. The hole near the rod pin is to the bimetallic plate and the farther the screw (47) is from the shaft of the arm (45), the less the sensitivity; and, conversely, the farther the dowel pin (59) is from the bimetallic plate and the nearer the screw (47) is to the arm's shaft, the greater the sensitivity. After the instrument is calibrated, the dowel pin must not under any circumstances be moved along the bar (11), nor the screw (47) along the arm. This would change the sensitivity of the instrument and, consequently, it would not conform to the coefficient recorded on the factory calibration chart. The positions of the screw and dowel pin are usually marked with paint after the test. Thus, if the screw or dowel pin should fall out while in transit from the plant, it can be returned to its previous position. Unmarked instruments whose screws or dowel pins have fallen out cannot be launched without another calibration.

The holes on the rod (44) are used to change the position of the temperature contact arm on the comb. Generally, speaking, changing the position of the bar (11) along the rod will not affect the sensitivity of the element. However, when the sensitivity is curvilinear (i.e., when the sensitivity coefficient is different for different parts of the comb), the use of these holes after calibration is not recommended, because a change in the position of the arm on the comb may change the sensitivity.

CONFIDENTIAL**CONFIDENTIAL**

- 12 -

CONFIDENTIAL**CONFIDENTIAL**

A screw (10) which joins the contact arm with the sensitivity arm (45) is used to regulate the pressure of the contact arm on the comb (in preparing the instrument for launching).

3. The temperature comb (31), in the form of an arc of a circle whose center is the pivotal axis (12) of the contact arm, consists of five toothed metal plates insulated from each other. The comb is attached with screws (34) onto the channel frame and is insulated from it by a celluloid lining. The individual plates (combs) are numbered from inside to outside; first, the control plate, then the 1st, 2nd, 3rd, and 4th. The width of each tooth is 2 mm. Adjacent teeth on each plate are 6 mm apart, except for the control plate, where they are 16 mm apart. The plates are assembled so that their teeth are not directly opposite each other, but are displaced one tooth relative to the next plate (Fig. 3).

Fig. 3 - Diagram of the Position of Teeth on the Temperature Comb.

If the teeth of all four plates were opposite each other, the temperature contact arm in sliding along the comb would fall into the gaps between the teeth, preventing uninterrupted recording of temperature changes. In their actual spacing, however, the contact arm (4) passes smoothly from a tooth of the first plate to a tooth of the second plate, then to a tooth of the third, then to a tooth of the fourth, then to a tooth of the first plate again, etc. Groups of four teeth arranged in this way are called sections. The sections are numbered from top to bottom (Fig. 1). The temperature comb has 19 sections and therefore 76 teeth. (For technical reasons, combs made in plants have 72 instead of 76 teeth; the first two teeth of the 1st section

CONFIDENTIAL**CONFIDENTIAL**

- 13 -

CONFIDENTIAL

CONFIDENTIAL

and the last two of the 19th are usually missing).

Each of the four teeth of each section has a number corresponding to the number of the plate on which it is located; thus, the teeth of all sections on the first plate are called first teeth; on the second, second teeth; on the third, third teeth; and on the fourth, fourth teeth.

With a temperature drop, the contact arm slides downward along the comb and therefore passes consecutively from the 1st to the 2nd tooth, from the 2nd to the 3rd, from the 3rd to the 4th, from the 4th to the 1st, etc, thus passing from one section to another. As the temperature rises, the contact arm slides upwards along the comb and the teeth will be passed in the opposite order. Since the temperature in the atmosphere usually decreases with altitude, the contact arm will consecutively pass teeth 1, 2, 3, 4, etc., as the radiosonde rises. If the radiosonde passes through an inversion, the order of the teeth will be reversed: 1, 4, 3, 2, 1, 4, etc. As we shall see, the radiosonde transmitter in this case sends signals in the form of interrupted tones (similar to telegraph dots). If the temperature contact arm rests on the first tooth of any section, one dot will be heard; if it rests on the second tooth of any section, two dots will be heard; on the third, three and on the fourth, four. Thus, when the temperature falls as the radiosonde rises, we shall consecutively hear one dot, two dots, three, four, one, etc. In inversions, the signals will be heard in the reverse order.

With the comb construction detailed thus far, the actual position of the contact arm can be determined accurately only for uninterrupted signal reception. Given this condition and knowing the number of the section in which the contact arm was resting before the ascent, we can confidently state the number of the section in which the contact arm is resting at any moment. However, signal reception is often interrupted. Let us assume that

CONFIDENTIAL

CONFIDENTIAL

- 14 -

CONFIDENTIAL**CONFIDENTIAL**

after an interruption we hear four dots. The four dots indicate only that the contact arm is resting on a fourth tooth and does not indicate which section that tooth belongs to. A fifth plate, called the control plate, was introduced to eliminate this defect. This plate was placed first from the inside (Fig. 3).

The distance between the teeth of this plate is eight times the width of one tooth (16 mm). Its teeth are positioned in the following way: the first tooth of the third section is sawed off, but there is a tooth of the same width opposite it on the control comb. Consequently, if the contact arm is resting on the 4th tooth of the second section, a further decrease in temperature will move it to the control comb instead of to the 1st tooth of the third section. The signal will therefore consist of seven consecutive dots (the reason for which will be given later) instead of one dot.

The next (2nd) tooth of the control comb replaces the 2nd tooth of the 5th section; the 3rd control tooth replaces the 3rd tooth of the 7th section; the 4th control tooth, the 4th tooth of the 9th section; the 5th control tooth, the 1st tooth of the 12th section; the 6th control tooth, the 2nd tooth of the 14th section; the 7th control tooth, the 3rd tooth of the 16th section; and, finally, the 8th control tooth, the 4th tooth of the 18th section.

The control comb permits accurate determination of the position of the contact arm even if there is a temporary interruption in signal reception. Let us assume that after a temporary interruption, we hear four dots, then one dot followed by seven dots. Thus, the control tooth here replaces a 2nd tooth in the temperature comb. Looking at the distribution of the control teeth on the comb diagram (which is drawn in at the top of the signal reception blank), we observe that the control tooth replaces a 2nd tooth in the 5th and 14th sections. The temperature difference between these two positions, however, amounts to about 40°. Therefore, knowing the initial posi-

CONFIDENTIAL**CONFIDENTIAL**

- 15 -

CONFIDENTIAL

CONFIDENTIAL

tion of the contact arm and the approximate height of the instrument, the true position of the contact arm can be accurately determined.

4. Each of the five plates of the radiosonde temperature comb is connected by means of insulated conductors with the spring contact strips (32) m_1 , m_2 , m_3 , m_4 , m_p , and m_k (Figs. 1 and 2). These are mounted on a celluloid backing (48), which is attached to the channel frame and thus insulated from the instrument housing. A rod (21) with sprocket wheels on it fits into a metal bar (49) which connects the two celluloid plates. The other end of the rod (21) rotates in a bearing which is also insulated from the instrument housing. The rod with the sprocket wheels is called a commutator. The sprocket wheels are placed opposite the contact plates and have different numbers of teeth.

Wheel n_1 , which is opposite spring contact strip m_1 (connected with the 1st plate of the temperature comb), has one tooth; wheel n_2 , opposite strip m_2 , has two teeth; wheel n_3 , opposite strip m_3 , has three teeth; wheel n_4 , opposite strip m_4 , has four teeth; and wheel n_k , opposite strip m_k , has seven teeth. Wheel n_p and strip m_p will be discussed later.

On the lower part of the commutator there is a pinion (19), connected by a gear drive to a cup gear (18) on the propellor shaft (16). This shaft is insulated from the instrument housing and is driven by the propellor at its lower end. The number of teeth on the cup gear (18) is one-fourth the number on the pinion (19) and therefore one complete revolution of the commutator corresponds to four turns of the propellor. The propellor blades are bent so that the air pressure on them (when the radiosonde is rising) causes the propellor to turn clockwise (looking downward) and consequently, causes the commutator with its sprocket wheels to turn counterclockwise.

The contact strips m_1 , m_2 , m_3 , m_4 , m_p , and m_k are regulated so that the sprocket teeth touch these plates when the commutator rotates. Thus, during one complete revolution of the commutator, the sprocket wheel n_1

CONFIDENTIAL

CONFIDENTIAL

- 106 -

CONFIDENTIAL

CONFIDENTIAL

touches its corresponding ~~strip~~ ^{strip} m_1 once (it has one tooth); wheel n_2 touches twice; n_3 , three times; n_4 , four times, and n_k , seven times. Thus, the number of such contacts is equal to the number of the comb plate.

In ~~connecting~~ the electrical circuit of the ~~transmitter~~ ^{radiosonde}, the wire from the negative terminal of the plate battery is fastened to clamp (36) on the metal bar (49). Thus, current from the negative terminal of the plate battery is supplied to the sprocket wheels. In order to close the plate circuit of the transmitter, the negative terminal of the plate battery must be connected to the filament at the tube prong which is connected to the positive terminal of the filament battery (Fig. 4). A wire from this prong is connected to the instrument housing. However, since the commutator is insulated from the housing, the plate circuit is still open. In order to close the circuit, the sprocket wheels must be connected to the instrument housing. This connection is made through the temperature contact arm.

Let ~~then~~ ^{the} temperature contact arm
(connected with the instrument housing)

be resting on the 4th tooth of any section. Then, current from the negative terminal of the plate battery will flow into the commutator, through the four-tooth sprocket wheel

(if its tooth is touching the ~~strip~~ ^{strip}) into the ~~strip~~ ^{strip} m_k . The latter is connected with the 4th plate of the comb, and therefore the current flows into

Fig. 4. Diagram for Connecting the ~~transmitter~~ ^{Radiosonde} into the Plate Circuit of the Transmitter

CONFIDENTIAL

CONFIDENTIAL

- 5 -

CONFIDENTIAL

CONFIDENTIAL

the latter, and from the 4th plate through one of its teeth (the one on which the contact arm is resting) into the temperature contact arm and into the housing. The plate circuit of the transmitter is thus closed and the transmitter sends a signal, ~~now~~, a solid whistle, if the commutator is not rotating and the tooth is touching the ~~strip~~ ^{strip}.

^{When} the commutator ~~starts to rotate~~, the plate circuit is opened and closed rapidly four times ^(by the four-tooth sprocket wheel) and four dots in rapid sequence instead of a solid whistle are heard in the reproducer. The four dots will be repeated (every 1.2 to 1.5 seconds) as long as the temperature contact arm is resting on the fourth tooth. As soon as it moves to another tooth (to the 1st, for example), one dot is heard instead of four. If the contact arm moves to a control tooth, seven dots will be heard because the sprocket wheel touching the ~~strip~~ ^{strip} has seven teeth, etc.

5. The above shows that ~~the nature of~~ the signals accurately indicate the number of the tooth upon which the temperature arm is resting, while a change of signals characterizes a change of the contact arm from one tooth to the next. Knowing the position of the contact arm on the comb and the air temperature before the instrument was released plus the sensitivity of the element, the temperature can be calculated easily when the signals change. Before the instrument is released, it is subjected to the so-called "exposure" (ground check); the temperature is recorded ~~according to~~ ^{with} an Assmann psychrometer and the position of the contact arm on the temperature comb is determined. This data is of assistance in finding the temperature when the signals change.

CONFIDENTIAL

CONFIDENTIAL

-78-
CONFIDENTIAL

-18-
CONFIDENTIAL

Example. Before release, $t_{\text{dry}} = -30^\circ$; the temperature contact arm is in the 13th section on the 3rd tooth at a point that is 0.6 of the width of the tooth (from top to bottom). This is customarily written thus: 13/3 (0.6). The sensitivity of the element is rectilinear and equal to 1.6° per tooth. It is necessary to find the temperature when the contact arm moves from the 3rd to the 4th tooth of the 16th section. The calculation is made as follows: Up to the beginning of the 14th section, the arm had passed 1.4 teeth; then it passed 4 teeth in the 15th section and 3 teeth in the 16th section. Thus, it had passed a total of 8.4 teeth. The temperature changed (decreased) by $8.4 \times 1.6 = 13.4^\circ$. Thus, a transfer from the 3rd to the 4th tooth of the 16th section corresponds to a temperature of $-30^\circ + (-13.4^\circ) = -43.4^\circ$.

The above example shows that the temperature can be calculated only when the signals change, because the true position of the contact arm is known accurately only at this time. ~~At other times, when the arm is moving along a tooth, its true position is unknown and the temperature at those times cannot be calculated.~~ For this reason, as we will see below, the temperature in ^{processing} ~~decoding~~ is not calculated for signals (^{Teeth} ~~which~~) received immediately after interruption. Instead, the calculation is ^{made for} ~~begin~~ at the next signal change.

Consequently, having noted in signal reception the moments of change, we can calculate the temperature for each of these moments. In ^{processing} ~~decoding~~; (see Chapter IV), it is also possible to calculate the height of the radiosonde when the signals change and thus obtain the distribution of temperature with ^{respect to} height over the region where the ^{radiosonde} ~~radiosonde~~ was released.

6. A Bourdon tube is used as the pressure element in the rasonde. One end of the tube is fastened ^{ed} to the holder (41) (which also supports the tem-

CONFIDENTIAL

CONFIDENTIAL

- 28 -
19CONFIDENTIAL
CONFIDENTIAL

perature element) and the other end is connected by a ^{rod} ~~bar~~ (14) and a sensitivity arm (30) to the pressure ^{contact arm} ~~element~~ (53). When the pressure decreases, the tube straightens and the pressure arm moves downward along the pressure comb (38). When it increases, the tube bends and the arm moves upward.

The holes ^{on} ~~in~~ the sensitivity arm (30), the ^{rod} ~~bar~~ (14), and the ^{bar} ~~rod~~ (15) are for the same purpose as they were in the temperature element, and the screw (37) or the dowel pin (50) must not be moved after checking.

^{In} ~~During~~ the factory ^{calibration} ~~check~~, the sensitivity of the pressure element is set so that a 10-12 millimeters (mercury column) change in atmospheric pressure will move the pressure arm 1 ^{tooth} ~~millimeter~~ along the pressure comb. The sensitivity of the pressure element is represented in the form of a graph ^{on which} ~~is plotted~~ ^{which determines} the position of the pressure arm on the comb ^{versus} ~~in dependence~~ upon the atmospheric pressure.

The Bourdon tube is carefully nickel-plated to prevent air penetration (through the pores of the metal). Despite this, however, after transportation or prolonged storage, the pressure arm is frequently displaced downward from the position it should occupy at a given atmospheric pressure according to the ^(calibration) ~~checking~~ certificate. This is most often due to the penetration of air into the tube through the pores of the metal or through a hole in a defective tube. It ^{also} ~~can~~ be caused by the liberation of adsorbed air molecules from the inner walls of the tube.

Before release, therefore, the position of the pressure arm should be checked against the ^{calibration} ~~checking~~ graph and a control priming of the pressure element should be made. The instrument should not be released in any case if the deviation exceeds the tolerance.

CONFIDENTIAL

CONFIDENTIAL

- 20 -
CONFIDENTIAL

- 20 -
CONFIDENTIAL

7. The pressure comb (33) is in the form of an arc of a circle whose center is the pivotal axis of the contact arm (12). It is fastened on the channel frame and insulated from it (and consequently from the housing) by a celluloid strip. The comb consists of two toothed plates, one metal and the other celluloid, put together so that the gaps between the metal teeth are filled by the celluloid. This provides smooth slipping ~~(without gaps)~~ of the pressure contact arm along the comb. In all, there are 18 metal (or silver, as they are called in ^{calibration} ~~checking~~ practice, since the pressure comb used to be made of silver) and 17 celluloid teeth on the comb. The celluloid and metal teeth are numbered individually from top to bottom (Figure 5). Thus,

Teeth 1s 1c 2s 2c 3s 3c 4s 4c

Fig. 5. Arrangement of the Teeth on the Pressure Comb

the first metal tooth from the top is called the first silver 1s, then the first celluloid, 1c; further 2s, then 2c, etc.

The pressure signals, in contrast to the temperature signals, are alike for all teeth of the comb. In order that there be no mistake in the ^{decoding} ~~spacing~~ of teeth numbers during signal reception, sequential signal reception must be obtained from all teeth which are passed over by the contact arm. To facilitate the ^{decoding} ~~spacing~~ of teeth numbers during a possible lapse in signal reception, the teeth are made both narrow and broad. The 3rd, 6th, 9th, 12th, 15th, and 18th teeth are three times wider than the adjacent teeth and therefore the time during which signals will be heard from these teeth is three times greater than for the adjacent teeth.

CONFIDENTIAL

CONFIDENTIAL

- 21 -
21

CONFIDENTIAL

- 21 -

CONFIDENTIAL

The metal teeth are positioned so that one wide tooth follows two narrow ones. The control metal tooth (17), ^{pasted} ~~placed~~ on the celluloid, is placed between 9s and 10s. These peculiarities in the arrangement and width of the teeth make it possible to correctly number the teeth during a lapse in pressure signals.

The width of the ^{Teeth} ~~teeth~~ decreases with the number of the teeth but the relative difference in ~~the~~ width is maintained ^{in order} ~~to~~ to keep the time required for the contact arm to pass over the teeth approximately constant in atmospheric layers with ^{very} ~~different~~ pressures.

8. The pressure ~~comb~~ ^{strip} is connected with an insulated conductor to a spring contact ~~plate~~ ^{strip} ~~mp.~~ A sprocket wheel n_p with a tooth in the form of a sector of a circle (intersecting an arc of 72°) is put on underneath this plate on the commutator. The pressure signal received, therefore, is a dash, lasting 0.2 of the time required for one commutator revolution, i.e., a duration of 0.2 to 0.3 second. Since the pressure sector n_p is placed on a common pivot with the temperature sprocket wheels, and since this pivot is connected to the negative terminal of the plate battery (the pressure contact arm is connected to the instrument housing in the same manner as the temperature contact arm), the pressure signal ~~can~~ be received independently of the temperature signals at any time when the pressure contact arm is resting on any metal tooth.

All temperature sprocket wheels are set on the ^{commutator} ~~axis~~ so that their last tooth (considering that the commutator is moving in a counter-clockwise direction, i.e., in the ascent of the instrument) is on the same line as the tooth of the one-tooth sprocket wheel. Consequently, if the one-tooth spro-

CONFIDENTIAL

CONFIDENTIAL

- 22 -

CONFIDENTIAL

- 22 -
CONFIDENTIAL

ket is touching its plate, then at that moment all remaining sprocket wheels are touching their plates with their last teeth. The pressure sector is set up on the commutator pivot so that its initial line (for counter-clockwise rotation of the commutator) is also on the same line as the tooth of the one-tooth sprocket wheel and consequently on the same line as the last teeth of all sprocket wheels. Therefore, when the pressure contact arm is resting on a celluloid tooth, the plate circuit of the transmitter is closed only through the temperature sprocket wheels, and only ~~dots are~~ ^{dots are} heard.

As soon as the pressure contact arm moves to a metal tooth, the plate circuit of the transmitter is closed through two independent paths, i.e., through the temperature sprocket wheels - (the temperature contact arm - housing, and through the pressure sector - the pressure contact arm - housing). The last dots of the temperature signals are transformed into a dash. If at a given time, for example, the temperature contact arm rested upon a first tooth, one dash would be heard instead of one dot; if on a second tooth, a dot and a dash instead of two dots; if on a third tooth, two dots and one dash; on a fourth tooth, three dots and one dash; and on a control tooth, six dots and one dash (Figure 6).

Observation of the appearance and disappearance of a dash in the temperature signals makes it possible to determine the times when the pressure contact arm is moving from a celluloid tooth to a metal tooth and vice-versa. Knowing the atmospheric pressure and the position of the contact arm on the comb at ^{release} ~~release~~ and using the sensitivity graph (see page 208 text), the pressures corresponding to these transition times can be determined.

In practice, the atmospheric pressure is not calculated for the transition times from tooth to tooth, but for the time when the ^(contact arm) ~~pointer~~ is on the

CONFIDENTIAL

CONFIDENTIAL

- 23 -

CONFIDENTIAL

- 23 -

CONFIDENTIAL

Position of the Temperature Contact Arm in any Section	Signals	Registration in Reception Procedure
When The Pressure Contact Arm is on a Celluloid Tooth		
On a 1st Tooth		1
" " 2nd "		2
" " 3rd "		3
" " 4th "		4
" " Control Tooth		K
When the Pressure Contact Arm is on a Metal Tooth		
On a 1st Tooth		1x
" " 2nd "		2x
" " 3rd "		3x
" " 4th "		4x
" " Control Tooth		Kx

Figure 6. Diagram of the Sequence of Temperature Signals in Dependence Upon the Position of the Pressure Contact Arm

middle of the silver teeth. Only when the moment of appearance of disappearance of the ^{signals} ~~signals~~ has not been noted is it necessary to make the calculation ~~not for the middle of the tooth~~ ^{instead of the middle} but for the beginning or end of ~~the~~ ^{the beginning or end of the signals} depending upon which is received ^{radiosonde several strands}.

9. The humidity element in the ~~radiosonde~~ ^{radiosonde} is a ~~part~~ ^{several strands} (1) of degreased human hair attached to extensions of the channel frame brought out through a slot in the vertical wall of the housing. The tuft is pulled in in the middle (2) by a bar, the other end of which is connected by a screw (56) to the sensitivity arm (52), which in turn supports the humidity contact arm (54). A bent metal plate (3) pushes into the humidity contact arm (54) from the top, the other end of the plate being secured to the vertical frame of the instrument. ^A ~~The~~ small spring presses the contact arm from the top, which

CONFIDENTIAL

CONFIDENTIAL

- 24 -

CONFIDENTIAL

CONFIDENTIAL

- 24 -

keeps the ~~hair~~ ^{strands} hair tight at all times.

When the relative humidity increases, the ~~hair~~ ^{strands} elongates and the humidity pressure arm under the pressure of the spring (3) is pushed downward along the comb (60); when it decreases, the ~~hair~~ ^{strands} contracts and the pressure arm, overcoming the resistance of the spring, moves upward along the comb.

In ^{calibration} the ~~hair~~ ^{strands}, the sensitivity of the receiver is regulated so that a humidity change of 6 to 10% moves the contact arm one tooth along the comb. The sensitivity is ^{shown} ~~represented~~ in the form of a graph, and the certificate is attached to the instrument (Figure 87).

If the contact arm is resting on the lower end of the humidity comb when the ~~hair~~ ^{strand} is far from saturation, the contact arm can be raised by moving the screw (55).

Note: In old radiosonde models, the screw (55) was missing, and the contact arm was lifted by carefully bending the extensions of the frame in which the ~~hair~~ ^{strands} of hair ^{are} fastened.

10. The temperature and air pressure usually change smoothly with height, and therefore the comb arrangements for these elements are designed to register these changes, rather than their absolute values. For transmission of humidity signals, however, this principle is unsatisfactory, since ^{the} humidity ^{variation} ~~changes~~ with height ^{is} frequently step-like and ^{sometimes} ~~at other times~~ very slight. In both cases, the principle of transmitting changes is unsatisfactory and therefore the device for transmitting humidity in the radiosonde is designed to transmit absolute values of humidity. This device operates in the following manner:

The humidity comb consists of ten teeth insulated from each other and from the housing. Since the sensitivity of the hair depends upon the relative humidity (increases with a decrease of relative humidity and vice-versa),

CONFIDENTIAL

CONFIDENTIAL

- 25 -

CONFIDENTIAL

- 25 -

CONFIDENTIAL

the teeth are made in different widths to maintain the sensitivity ^{obtained} ~~in~~ ^{calibration} ~~in~~ (6-105 per tooth). The first six teeth (numbering the teeth from top to bottom) are each 2 millimeters wide, while the last four are each 3 millimeters wide.

There is also a humidity commutator, consisting of a celluloid disc (39) with ~~contact~~ ^{bars} plates, a switch (2), and a drive gear.

The celluloid disc is fastened to the channel frame and carries 13 ^{bars} ~~com-~~ ~~tact~~ plates; each of these are 18° wide (Figure 7). The ^{shaft} ~~pivotal~~ ~~axis~~ in the center of the disc has a sliding contact (8-Figure 11) attached to it which moves (when the ^{shaft} ~~disc~~ rotates) along the ^{bars} ~~plates~~ $f_1, f_2, \dots, f_{10}, P_1, K_1, K_2$.

Fig. 7. Diagram of the Position of the Plates on the Humidity Commutator

The ^{shaft} ~~pivotal axis~~ of the sliding contact is connected through a worm gear to the main commutator (with the sprocket wheels). Rotation of this commutator drives the sliding contact. The drive is geared down so that ^{the} ~~the~~ sliding contact makes one revolution for every 20 commutator revolutions. The ten ^{bars} ~~plates~~ f_1, \dots, f_{10} together occupy a semicircle or 180°. Consequently, the sliding contact passes over the ten ^{bars} ~~plates~~ in the same period of time that the commutator makes ten revolutions. Thus, in one complete revolution of the main commutator (21), the sliding contact passes over exactly one ^{bar} ~~plate~~.

CONFIDENTIAL

CONFIDENTIAL

- 26 -

CONFIDENTIAL

CONFIDENTIAL

- 26 -

The same holds true for the three individually located ~~plates~~ ^{bars} P_K , K_1 , and K_2 . Each of the ten ~~plates~~ ^{bars} f_1, \dots, f_{10} are connected ~~with~~ ^{by} an insulated conductor to the corresponding tooth on the humidity comb. The ~~plates~~ ^{bars} K_1 and K_2 are jumpered together and connected directly to the instrument housing. The ~~plate~~ ^{bar} P_K is connected by an insulated conductor to the control tooth of the pressure comb, which is situated between its 9th and 10th metal teeth.

Since the sliding contact is connected with the main commutator (21), which is supplied from the negative terminal of the plate battery, and the humidity contact arm is connected with the instrument housing, the entire ~~transmitting~~ ^{radio send} system for transmitting humidity indications is also connected (in parallel with the pressure and temperature systems (and is independent of them) in the plate circuit of the transmitter).

Let us assume that the humidity contact arm is resting on the 5th tooth of the comb. As soon as the sliding contact ~~reaches~~ ^{reaches} the ~~plate~~ ^{bar} f_5 in its rotation, the plate circuit of the transmitter will be closed and the transmitter will send a signal as long as the sliding contact moves along the ~~plate~~ ^{bar} f_5 . As ~~soon~~ ^{soon} as the sliding contact passes this ~~plate~~ ^{bar}, the plate circuit is opened and the signal stops. As it rotates further (in a counter-clockwise direction), the sliding ~~contact~~ ^{will} ~~reaches~~ ^{reaches} the ~~plate~~ ^{bar} P_K .

If at this moment the pressure contact arm is resting on the control tooth (between 9s and 10s), the plate circuit of the transmitter will be closed through the pressure contact arm, and the transmitter will send a signal until the sliding contact passes through the plate P_K . If the pressure contact arm is resting on any other tooth (the control tooth is ~~placed~~ ^{placed} on celluloid and is therefore insulated from the pressure comb), there will be no signals when the sliding contact passes over the plate P_K .

CONFIDENTIAL

CONFIDENTIAL

- 32 -
CONFIDENTIAL

- 27 -
CONFIDENTIAL

Plates K_1 and K_2 , designated "call", are connected directly to the housing and thus one signal, a dash, is heard when the sliding contact hits K_1 and another signal is heard after a short interval, the second corresponding to K_2 . These are the call signals (in practice, they are usually called control signals).

Let us now assume that the temperature contact arm is resting on the 4th tooth and thus 4 dots are heard. As soon as the sliding contact touches K_1 , a dash will be heard instead of four dots (Figure 8), lasting for one revolution of the main commutator, i.e., 1.2 to 1.5 seconds. The sliding contact then crosses the plate K_2 and a dash is heard instead of four dots. When the contact leaves K_2 , four dots are again heard.

Let us assume that the humidity contact arm is resting meanwhile on the 5th tooth (Figure 8). Then the plate circuit must be closed next through the 5th plate, f_5 . Therefore, from the plate K_2 to the plate f_5 , the four dots are repeated five times. If the temperature contact arm had rested upon the 3rd tooth, three dots would have been repeated five times, etc. Thus, by counting the number of times the temperature signal is repeated from the end of the second call signal to the next humidity signal, the number of the tooth (or the ^{bar}plate) upon which the humidity contact arm is resting at ~~the~~³ given time, is determined.

When the pressure contact arm is resting on the control tooth, three call signals will be heard instead of two. This must be noted in reception procedure, because the presence of a control pressure signal is important for determining the teeth numbers on the pressure comb.

Knowing the relative humidity and the position of the contact arm on the comb when the instrument was released, and also the sensitivity of the element, the relative humidity can easily be found for the times when the contact arm is ~~moving~~^{moving} from one tooth to another.

CONFIDENTIAL

CONFIDENTIAL

- 28 -

CONFIDENTIAL

- 28 -

CONFIDENTIAL

Pos. of Con- tact arm on Humidity Comb	Pos. of Con- tact arm on Temp. Comb.
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Signals

Record-
ing of
Humidity
Signals

Fig. 8. Diagram of the Sequence of Humidity and Temperature Signals

11. The instrument is placed in a box before ^{launching} release (Figure 9) to protect the ~~parts of the instrument~~ ^{components} from rain, freezing, and other factors which affect the operation of the rasende adversely ^{and} ~~and also~~ to protect the elements from direct solar radiation. The thin pasteboard box is coated with enamel paint for moisture-protection. Facilities are provided in the upper part of the box for tying the instrument to the balloon. There is a door on the narrow side of the box which is opened for taking the ground check, after which (before ^{launching} ~~release~~) it is lock with ^{ed} ~~special~~ ^{special} clamps (in the ^{old} ~~new~~ models, there were two little windows). The box is fastened to the instrument with two metal clips.

12. There is an additional side shield on one wall of the box to protect the elements from solar radiation. This is a sheet of thin pasteboard, painted with white enamel, and provided with holes for attachment (with tacks) to the box (Figure 9). There must be an air gap of not less than 1 centimeter between the pasteboard wall and the additional shield. This well-ventilated air gap is reliable protection from ^{the sun} ~~solar rays~~.

CONFIDENTIAL

CONFIDENTIAL

29

CONFIDENTIAL

CONFIDENTIAL

- 29 -

13. The propeller has four duraluminum blades, each 0.3 millimeter thick. The upper blades are set up vertically, and the lower ones at an angle of 45° with the horizontal. The propeller is set on a shaft and fastened with a cotter pin. During ascent of the instrument, the propeller rotates clockwise (observed from the top). This makes the sprocket wheels rotate ~~away from~~ ^{away from} the contact ~~strips~~ ^{strips}, and not ~~towards~~ ^{into} them (which might cause jamming). ~~This also~~ ^{of 3rd} ~~also~~ ^{also} ~~pro-~~ ^{pro-} ~~vides~~ ^{pro-} ~~rotation of the sliding contact~~ ^{vides} ~~which~~ ^{vides} ~~the additional shield~~ ^{vides} ~~is correct~~ ^{vides} for the proper sequence of the call and counting humidity signals (counter-clockwise).

14. An extension rod is inserted in the special holes (9) on the bottom of the housing and serves to remove the counter ~~weight~~ ^{weight} from the instrument so that it will not become fouled in the propeller.

B. ^(Radiosonde) ~~The Radiosonde~~ Transmitter

Fig. 10. Schematic Diagram of the ^(Radiosonde) ~~Radiosonde~~ Transmitter

The schematic diagram of the ^(Radiosonde) ~~Radiosonde~~ transmitter shown in (Figure 10) shows that ~~it makes~~ ^{it makes} use of a "three-point" Hartley oscillator circuit. This

CONFIDENTIAL

CONFIDENTIAL

- 3 -
CONFIDENTIAL

CONFIDENTIAL

- 30 -

circuit is called "Three-point" because the induction coil L ^{if connected} to the rest of the circuit at three points. The tubes UB-107, UB-110, or UB-152 can be used as ^{the} oscillator. When plate and filament batteries are provided, high-frequency oscillations are generated in the tuned circuit LC. One end of the induction coil L and one of the plates of the variable condenser C are connected to the grid of the tube. Thus, oscillations from the tuned circuit are transmitted to the grid. ~~The magnitude of the influence of the tuned circuit oscillations upon the grid depends upon the coupling of the tuned circuit with the grid. This coupling is determined by the position of the tap (1).~~ ^{The amount of feedback} ~~The greater the coupling, the greater the influence of oscillations on the grid.~~

The voltage oscillations on the grid amplify or decrease the plate current, which, in ^{turn} ~~the final analysis~~, transfers additional energy into the tuned circuit to compensate for damping losses in the circuit. ^(can be moved) ~~moving the tap (1) along the coil L~~ ^{it is possible to select the feed-back} at which this additional energy will fully compensate the energy losses in the tuned circuit, and undamped high-frequency oscillations will be maintained in the latter.

Oscillations in the tuned circuit stop if the plate circuit is opened. The oscillations also stop if both plates of the variable condenser are accidentally short-circuited. In this case, the capacitance element is taken out of the circuit, and the tuned circuit, as such, ceases to exist.

The high-frequency oscillations generated in the tuned circuit LC are radiated by the latter into the ^{surrounding medium} ~~the ether~~, where they can be received by a short-wave receiver. Radiation of a closed tuned circuit is weaker than an open ^{circuit}, however. Oscillations from the tuned circuit $L_k C_k$ (Figure 11)

CONFIDENTIAL

CONFIDENTIAL

- 31 -

CONFIDENTIAL
- 31 -
CONFIDENTIAL

Antenna

Counter ~~light~~ ^{coil}

Fig. 11. Diagram for Transmission of Oscillations From a Closed into an Open Tuned Circuit

Fig. 12. Diagram of Autotransformer Coupling of Two Circuits

are therefore first transmitted into an open antenna circuit, and the ~~light~~ ^{radiated in all directions} radiated ~~them into the light~~.

An open tuned circuit can include a coil L_A for coupling with the tuned circuit $L_K C_K$. The capacitance is distributed along the entire length of the conductor. In this case, the lower end C_{A1} assumes the role of the second plate of the condenser and is called a ~~counterlight~~ ^{counter coil}.

It is also possible to do without the special coupling coil L_A if the so-called autotransformer coupling is used. In this case, a few turns of the induction coil in the closed tuned circuit $L_K C_K$ replaces the coupling coil L_A (Figure 12). The antenna and counter ~~light~~ ^{coil} are connected with the coil L_K through the taps (1) and (2). The part of the coil between (1) and (2) is the antenna coupling coil. Maximum coupling, which characterizes maximum delivery of the ~~energy~~ ^{energy} of oscillations from the tuned circuit $L_K C_K$ into the antenna, can be obtained by changing the position of these taps. This ^{brightness} can be determined by the ~~heating~~ ^{brightness} of an indicator bulb ("mikro") connected in series in the antenna, or by other types of indicators ~~(indicators are discussed in detail on pp. 50-51)~~.

CONFIDENTIAL

CONFIDENTIAL

- 32 -
CONFIDENTIAL
CONFIDENTIAL

Since the tap (1) is connected to the negative terminal of the filament battery, the counter ^{poise} can be connected directly to the positive terminal of the same battery, or to its equivalent, the ^{radiating} housing. (Figures 4 and 12). Thus, ~~adjusting~~ ^{are adjusted for} taps (1) and (2) ~~is done~~ with two purposes:

- 1) to obtain maximum ^{feed} ~~feed~~ back to the grid, providing complete compensation of damping in the tuned circuit and thus undamped oscillations there; and
- 2) to obtain maximum coupling of the tuned circuit with the ^{the} antenna, providing maximum "transfer" of these oscillations (energy) into the radiating network (into the antenna).

The amount of energy delivered from the tuned circuit into the antenna ^{depends} ~~depends~~ not only upon their coupling, but upon how close the wave radiated by the tuned circuit is in wave-length to ^{the} ~~the wave~~ of natural oscillations in the antenna and upon the resistance of the antenna and counter ^{poise} ~~poise~~. When the first two are equal in value (i.e., in the case of resonance oscillations), delivery is maximum.

The wave-length radiated by the tuned circuit can be varied by changing the capacitance of the variable condenser C or the inductance of the coil L. The greater C and L, the longer the wavelength and vice-versa. Since the number of turns on the coil is constant for ^{a given transmitter} ~~any transmitter~~, the ^{wave length} ~~wavelength~~ can be changed only by changing the capacitance of the variable condenser C. The capacitance and inductance in the antenna are distributed along its entire length, and it is therefore possible to change the natural wavelength of the antenna by shortening or ^{lengthening} ~~lengthening~~ the antenna and counterpoise.

And thus, by changing C (moving taps 1 ~~and~~ 2) and changing the ^{length} ~~length~~ of the antenna and counterpoise, the transmitter can be adjusted to the de-

CONFIDENTIAL

CONFIDENTIAL

- 33 -
CONFIDENTIAL

CONFIDENTIAL
- 33 -

sired frequency and to ~~the~~ maximum energy transfer from the ~~tuned~~ circuit into the antenna. The transmitter wavelength should be selected, first, to eliminate interference, and, second, to provide good signal audibility when the ~~transmitter~~ ^{radiosonde} is quite distant from the point of release (the ~~transmitter~~ ^{radiosonde} may be carried 50 to 100 kilometers away in strong winds).

The paths for the ~~direct~~ ^{direct} and alternating components of the plate current are divided in the transmitter. ~~This is accomplished by the fixed condenser~~ ^{by the fixed condenser} C_1 and the high-frequency choke Dr (Figure 10). The condenser C_1 blocks the direct component of the plate current from the tuned circuit LC , but does not block the high-frequency oscillations of the tuned circuit from the plate. The high-frequency choke blocks high-frequency oscillations from the plate battery, but freely passes the direct component of the plate current.

(Radiosonde)
Fig. 13. Arrangement Diagram of the ~~Transmitter~~ ^{Radiosonde}

The arrangement diagram of the transmitter is shown on Figure 13. The

CONFIDENTIAL

CONFIDENTIAL

- 34 -
CONFIDENTIAL

- 34 -
CONFIDENTIAL

transmitter is mounted on a textolite panel, in which there are holes (a socket) for inserting the tube prongs. The tubes UB-107, UB-110, and UB-152 generate sufficient power and are very economical, which ~~explains~~ ^{explains} their use, since the capacity of the batteries used to supply the transmitter is very low.

Some of the parameters of these tubes is shown in Table 1.

Table 1

Tube	Filament Voltage (volts)	Filament Current (milliamps)	Plate Voltage (volts)	Plate Current (milliamps)	Amplification Factor (μ)
UB-107	4	75 ± 10	120	7.5 ± 2.4	11 ± 1
UB-152	2	112 ± 10	80	5.5 ± 2.5	13 ± 2
UB-110	4	75 ± 10	160	4.2 ± 1.3	25 ± 5

The choke Dr consists of 80 to 100 turns of insulated wire 0.10 to 0.12 millimeters thick wound on a pasteboard cylinder which is fastened in an upright position. One end of the choke coil is soldered to the plate pin and to a plate of the fixed condenser C_1 . The other end is left unconnected. When the instrument is ready for release, ~~this~~ ^{this} end is connected to the positive terminal of the plate battery.

The tuned circuit induction coil L has a basket winding of 11 to 12 turns of insulated wire 0.4 to 0.7 millimeters thick wound on pasteboard dipped in paraffin (in the old models, the wire was wound on a rectangular celluloid sheet). The coil turns have bare loops which can be connected to taps (1) and (2) when the transmitter is being tuned (see Figures 10 and 12). The loops are placed as shown in Figure 11 (on the left). If tap 1 is placed on loop 1, and tap 2 is progressively moved to loops 2, 3, 4, ..., 9

CONFIDENTIAL

CONFIDENTIAL

- 35 -

CONFIDENTIAL
- 35 -
CONFIDENTIAL

we introduce an increasing number of turns into the antenna coupling coil. If we leave tap 2 on loop 8, for example, and move tap 1 progressively to loops 2, 3, 4, etc, we decrease the coupling with the antenna but increase the feedback of the tuned circuit into the grid. In the old models with coils wound on celluloid, the position of the taps was different (See Fig. 14, right).

Fig. 14. Position of Taps on Induction Coils of the New (Left) and Old Radiosondes

The end of the coil, where loop 1 is located, is soldered to the rotor of the variable condenser and to the grid pin of the tube socket, and the other end, where loop 9 is located, is soldered to the stator of the variable condenser and to the second plate of the fixed condenser.

The variable condenser C comprises two rectangular metal plates, having a celluloid lining between them. One of the plates is stationary on the rectangular paraffined pasteboard, on which the induction coil is wound. The second plate is set on a screw, by means of which the distance between these plates can be changed. Increasing the distance decreases the capacitance and vice-versa. In the old radiosonde models, the variable condenser consisted of 2 stationary plates and one plate which could be moved into or out of the space between the first two. The greater the area of the moveable plate enclosed between the stationary plates, the greater the capacitance, and conversely, the smaller this area, the less the capacitance.

As was mentioned previously (see Fig. 4), the radiosonde is connected in series in the plate circuit of the transmitter between

CONFIDENTIAL

CONFIDENTIAL

- 36 -
CONFIDENTIAL

- 36 -
CONFIDENTIAL

the negative terminal of the plate battery (B minus) and the positive terminal of the filament battery (A plus) ~~is connected~~ in the following way:

B minus is connected to ~~clamp~~ ^{clamp} 36 (Figure 1) on the metal strip in which commutator 21 rotates. Two small wires, one ending in a tap and the other in a fork, are soldered to a filament pin on the socket. In later models, the transmitters are not equipped with forks. The wire from the filament pin is connected to ~~a screw which~~ ^{the which} fastens the transmitter to bracket 57 (Figures 1 and 2) of the housing. When the instrument is being prepared for ~~launching~~ ^{launching}, the fork is attached to one of the notches of 57 (Figures 1 and 2) in which the transmitter is fastened and rests against the upper band of the housing (to prevent its working out when the instrument is jarred). Thus, this filament pin is connected with the instrument housing, and it is also connected to the wire with a tap which is brought to the induction coil L (tap 1 on Figure 10). Thus, by connecting A plus and the counterpoise to the housing, we supply A plus to the tube pin, to the induction coil, and simultaneously connect the counterpoise with tap 1.

The lead from the A plus is usually brought out through the pasteboard box to the outside and connected (when required) to the counterpoise, which previously should have been securely attached to the housing (through the ~~rod~~ ^{rod}). In recent ~~models~~ ^{radiosonde} models, a special ~~clamp~~ ^{clamp} on the V-shaped frame 27 (Figure 1) is provided for attaching the counterpoise to the instrument housing. The lead that is connected to this clamp is brought outside between ~~the~~ ^{the} pasteboard box and the bottom of the frame and then connected with the counterpoise. The lead from the A minus is connected directly to the wire which is soldered to the other filament pin on the socket.

CONFIDENTIAL

CONFIDENTIAL

- 47 -
CONFIDENTIAL

- 37 -
CONFIDENTIAL

As seen from Figure 10, B minus must be connected to A plus as this is the only way in which the plate circuit will be closed. As was indicated, B minus is connected to A plus through the commutator, the plate sprocket wheel, combs, contact arm, and the ~~housing~~ ^{strips}, the latter being connected directly to a plus.

After these connections are made, the transmitter can operate if the lead from A plus is connected to the counterpoise (to the housing) and if the one-tooth sprocket wheel touches its ~~plate~~ ^{strip} (if this is true, all the sprocket wheels touch their ~~plates~~ ^{strips} and the plate circuit is closed through several of them).

An antenna 7 meters long and a counterpoise 5 meters long are attached to the ~~radiosonde~~ ^{radiosonde}. The ~~experience of~~ ^{have found} polar aerologists ~~has shown~~ ^{this} that an antenna 3 meters long can be ~~successfully used~~ ^{used}. If the ~~radiosonde~~ ^{this} antenna is used, the length of the counterpoise is selected during tuning (it usually does not exceed 5 meters, and sometimes can be shortened to 3 or 3.5 meters). The shorter antenna ~~facilitates~~ ^{facilitates} release of the ~~radiosonde~~ ^{radiosonde} in strong winds ~~earlier~~ ^{earlier} and makes the transmitter ~~more~~ ^{wavelength} more stable ~~operation~~. The signals, however, are much louder from the 7 meter antenna. Sometimes a transmitter cannot be tuned to deliver into the 3 meter antenna. The 3 meter antenna, therefore, should be used mainly in strong winds, and the 7 meter antenna under normal conditions.

The antenna is attached to twine (either wound around it or tied to it with a small cord), one end of which is tied to the balloon and the other to the ~~radiosonde~~ ^{radiosonde} ring. One end of the antenna is connected to the lead which is brought out through hole 58 (insulated from the housing) in the vertical wall of the housing. The other end is left free. When the balloon is tied

CONFIDENTIAL

CONFIDENTIAL

- 38 -
CONFIDENTIAL

- 38 -
CONFIDENTIAL

on, the cord stretches and the antenna is held in a vertical position. The antenna ~~therefore~~ should be given some slack so that it will not break or be greatly stretched when the cord is tightened by the balloon.

The counterpoise is wound on the extension rod and dropped below. The end of the extension rod must be ~~dropped~~ below the propeller's plane of rotation. Otherwise, the counterpoise may become fouled in the propeller when the ^{radiosonde} ~~radiosonde~~ rocks in flight, which will ^{interrupt} ~~breakdown~~ transmission or ^{convert} ~~transform~~ the signals into a solid whistle (since the propeller will not be rotating).

C. Transmitter Supply

Primary batteries, made up of Le Clanche dry cells, are used to supply the transmitters. The Le Clanche cells manufactured in 1941 were ^{were some-} ~~constructed~~ ^{what different from} ~~slightly~~ ^{are} differently than preceding numbers. In these, the negative electrode, zinc, is no longer used as the cylinder, but is a zinc plate, covered with filter paper with an agglomerate. The zinc plate is placed in the cylinder which is made from paraffined paper. (Figure 15, ^{16, 17, 18, and} ~~showing~~ ^{various} ~~90~~ ^{are} ~~dry cells connected in series, as~~ ^{omitted}).

The plate battery consists of 30 dry cells connected in series, delivering 45 volts. When the voltage drops to less than 38 volts, the battery is considered worthless. The plate battery has a capacity of 0.04 ampere-hours, i.e., it can deliver 20 ^{amps} ~~milliamperes~~ for two hours.

^{in series} Two ~~plate~~ batteries are usually used to supply the transmitter, i.e., 90 ^{Fig. 12. Diagram showing the connection of cells in the F} volts is applied to the plate. However, experiments begun in 1935-1936 in Bukta Tikhaya (V. G. Kanaki ~~and~~ ^{subsequent} A. A. Ledokhevich) on decreasing the plate voltage and the ~~following~~ ^{radiosonde} check of these experiments ~~in later years~~ by other polar aereologists (P. M. Bushev, I. I. Tsarev, V. Ye. Blagodarov, F. D. Shipilev) showed that the ~~radiosonde~~ ^{radiosonde} transmitter can operate with a

CONFIDENTIAL

CONFIDENTIAL

- 37 -

CONFIDENTIAL

CONFIDENTIAL

- 39 -

plate voltage of 45 volts, which would permit ^{rasondes} ~~rasondes~~ to be released with one battery instead of two. The drop in plate voltage, besides reducing the weight of the ^{rasondes} ~~rasondes~~, would decrease the plate current, thus increasing the life of the battery. The release of ^{rasondes} ~~rasondes~~ with one battery would ~~also~~ increase the height of ascent and thus would be very useful.

The filament batteries of the old model consisted of four LeClanche cells connected in series. The size of the battery was 3.5 x 3.5 x 7.5 ~~cc~~ ^{double-centimeters} and the weight was around 150 grams. The emf of the battery was about 6 volts. Its voltage under load should not in any case fall below 4.5 volts. The capacity of the filament battery is 0.2 ampere-hours, i.e., it can deliver 100 milliamperes for two hours, and thus can heat the filaments of the UB-107 or the UB-110 for this period.

A lower filament voltage and a higher filament current is required for the UB-152 than for the UB-107 or UB-110. In releasing a rasonde using a UB-152, therefore, the filament battery must be reconnected: two pairs of cells connected in series are connected in parallel. The battery then has an emf of 3 volts, while its capacity is twice that of the battery of four cells connected in series, and it thus can heat the filament of the UB-152 for three hours. This battery is useless when its emf falls below 2.5 volts.

If there are no filament batteries (made up of four cells), they can be made from the plate batteries. To do this, three rows of five cells connected in series are connected in parallel. The emf of this battery is about 7 volts (or about 7.5 volts). Another filament battery can be made from the remaining 15 cells of the plate battery.

If a filament battery must be made from a plate battery for the UB-152

CONFIDENTIAL

CONFIDENTIAL

- 40 -
CONFIDENTIAL

- 40 -
CONFIDENTIAL

tube, five rows of three cells connected in series should be connected in parallel. This battery delivers about 3.0 to 3.5 volts. It should be ^{remember} kept in mind that filament batteries made from plate batteries are not very reliable and wear out very rapidly. They ^{should} be used only in exceptional cases. The filament batteries made from cells of the dry battery BAS-80 are more reliable. Three of these cells connected in series deliver about 3.6 to 3.8 volts under load. They give a better account of themselves in operation than either the filament batteries of LeClanche cells (factory-produced) or those made from plate batteries. The filament batteries manufactured in 1941 consisted of 15 ~~cells~~ cells of the same type as the plate batteries and were connected as described for the 7-volt filament battery. More recent issues of batteries have much smaller cells and filament batteries cannot be made from them.

Batteries from new consignments and batteries made up at the location from ~~dry~~ batteries or plate batteries have different properties. In all of these cases, one filament and one plate battery should be tested. For this purpose, the battery is connected to the transmitter and the voltage at the terminals under load is measured every 5 or 10 minutes. The test lasts from 1 to 1½ hours. If, during an hour of continuous operation, the filament battery voltage has not fallen below 3.5 volts, the consignment can be considered to be good. The plate battery voltage for the same period should not fall below 30 volts.

The device shown in Figure 220 suggested by A. A. Girs, mounted on a board 40 x 30 centimeters, should be used to test batteries at stations. The contacts for the voltmeter leads (150, 115, 4) ~~should be~~ made in the form of jacks, where the ends of leads can be inserted. All the wiring

CONFIDENTIAL

CONFIDENTIAL

- 48 -
71 -
CONFIDENTIAL
- 41 -
CONFIDENTIAL

Fig. 20. Arrangement Diagram of the Desk for Testing the Quality of Batteries

can be made underneath the board. A transmitter with a tube is installed permanently. The proper terminals of the batteries under test are connected to the clamps B-, A+, B+, and A-.

The transfer switch B is then thrown to the contacts 150 and B-A+, and the transfer switch P to the contact B+. The voltmeter then shows the voltage of the plate battery. The transfer switch B is then thrown to the contacts 15 and A-, and the transfer switch P to the contact B-A+. The voltmeter then reads the voltage of the filament battery. In order that the correct position of the switches will not be forgotten each time, the following rule can be remembered: the transfer switch B can be set on either of the pairs of contacts, and the transfer switch P can be put on the contact B-A+ only when this contact is not occupied by the transfer switch B; if this contact is occupied, then P must be thrown to B+. The voltmeter indication will immediately show which voltage is being measured, that of the plate battery or the filament battery.

END
CONFIDENTIAL
CONFIDENTIAL

- 42 -

CONFIDENTIAL
CONFIDENTIAL

Chapter II - Equipment of a First-Rank Arctic Aerological Station

The ^{main} ~~basic~~ installations of an Arctic aerological station which ~~is con-~~ ^{cerned with daily sounding of the atmosphere with the help of} ~~radiosondes~~ ^{radiosondes} are:

1. The ² ~~aerological~~ ^{radiosonde} laboratory, where the ~~radiosonde~~ is prepared for launching and the signals are received and processed.

2. The aerological pavilion, where gas is generated and the balloons are ^{filled} ~~filled~~.

3. The place where the instruments are ground-checked and launched.

^{Indent} Basic data on the construction and equipment of these installations at polar stations and a ^{brief description} ~~short description~~ of the construction of some basic instruments in the equipment of an aerological station follows:

Section 1 - The Aerological Laboratory

Fig. 21. Plan-Diagram of an Aerological Laboratory in the Arctic.

Fig. 21 shows ^{the} ~~a~~ schematic diagram of an aerological laboratory ~~and the arrangement of the necessary equipment~~ which is best fitted to Arctic conditions. This plan should be consulted when equipping a ^{laboratory} ~~laboratory~~ or building a new one. The aerological laboratory should consist of two adjoining rooms: a) the room for preparing and calibrating ~~rasondes~~ ^{radiosondes} and b) the processing room.

CONFIDENTIAL

- 43 -

CONFIDENTIAL
CONFIDENTIAL

- 13 -

A. The Room for Preparing and Checking ^{Radio sondes} Resondes

We ~~first~~ ^{first} ~~describe~~ ^{describe} the equipment and then ~~a description~~ ^{a description} of the construction and operation of the individual instruments.

The main working area in the room is the table for preparing the instruments. A board with a set of ^{tools} ~~instruments~~ ^{needed to} ~~required~~ in preparing the instruments is hung on the wall (to the left of the table). A vise is installed on the left edge of the table. A special stand for preparing the ~~radio sonde~~ ^{radio sonde} is set up on the ~~table~~ ^{Table}. The indicator for tuning the transmitter is situated on the wall (or at the wall on the table) to the right. There should be three sockets on the wall, one for connecting the lighting, one for the soldering iron, and a third for the indicator and devices for checking the electrical circuit of the ~~radio sonde~~ ^{radio sonde}. On the table, there should also be a voltmeter, a soldering iron, materials for soldering, ~~tools~~ ^{tools} with electrolyte, ~~and~~ ^{and} bulbs for filling batteries, weights ~~with counterweights~~ ^{with counterweights} for suspending the ~~resonde~~ ^{radio sonde}, etc.

There should also be a cabinet to contain the ~~resondes~~ ^{radio sondes}, transmitters, plate and filament batteries, counterpoises, antennas, propellers, and other ~~materials necessary~~ ^{gear needed to} in preparing the instrument.

There is also a table for the Garf instrument, with which is used to make a control calibration of the pressure tube of the ~~resonde~~ ^{radio sonde}. A manometer is attached to the wall, and a pump is placed on a special support to the right of the table. The log-book of the control calibration of the pressure element should always be on the table.

The ~~unit~~ ^{unit} for the control calibration of the temperature and humidity ~~elements~~ ^{elements} is on the third wall. The rules of calibration and the description of the equipment are given in "Instructions for the Calibration of Meteorological and Aerological Instruments" (reference 6 in Bibliography).

The table for signal reception is located at the window which opens

CONFIDENTIAL
CONFIDENTIAL

-44-

CONFIDENTIAL

-44-

onto the place where the ^{radiosonde} ~~sondes~~ are launched. There are two KUB-4 receivers on the table, one (the one on the right) being an auxiliary receiver. The batteries supplying the receivers and other units are under the table. The charge-discharge switchboard and the antenna switch are on the wall to the left of this table. Sound-powered telephone equipment is installed under the left edge of the table, the tube of which is to the left on the table. The telephone connects the place of ground-checking and launching, the aerological pavilion, and the observation points with the aerological laboratory. There is a push button on the table to the left to transmit the signals "close the transmitter circuit", "release the sonde", etc. A stop-watch with 100 divisions on the dial is placed at an angle to the surface of the table to the left of the receiver.

There is a ^{small} ~~small~~ table to the right of this table for ground check of ^{radiosondes} ~~sondes~~. There is a special support with a blower (Fig. 22), on which the ^(radiosonde) ~~sonde~~ is installed. There is a hook in the wall over the small table to support an Assman psychrometer. The hook must be ^{installed} ~~installed~~ so that the elements of the thermometers are on the same ^{height} ~~level~~ as the temperature element of the ^{radiosondes} ~~sondes~~. A bulb with distilled water for wetting the ^{60 F. 12} ~~bottom~~ of the psychrometer is ^{as are} ~~as are~~ hung on the wall, and a barometer (if the meteorological room is distant) and contact clocks, ^{which} ~~sending~~ signals for readings at ^(observation) ~~points~~ ~~points~~.

Fig. 22. The ventilation unit (blower) used at Bukhta Tikhaya.

(Describe in) We now give ~~detail description of~~ the more important individual instruments.

CONFIDENTIAL**CONFIDENTIAL**

- 45 -

CONFIDENTIAL

- 45 -

1. The Ventilation Unit

^{radiosonde}
~~in the~~ ground check of ~~a radiosonde~~ both in shelter and in air, ^{required} continuous ventilation of the elements ~~is necessary~~, and a blower must be ^{made} ~~prepared~~ for this purpose. The blower used at the ~~Bukhta Tikhaya~~ polar station and at Cape Chelyuskin ^{uses} employs a d.c. motor ~~to~~ (1/32 horsepower) to rotate an aluminum multiblade propeller. The propeller blades are bent so that the air passes through the shaft from top to ^{bottom} ~~bottom~~ and ^{keeps} ~~keeps~~ the motor's heat ^{away} ~~from~~ the elements. If a motor of the ^{required power} ~~necessary~~ ~~power~~ is not available, a blower can be constructed, as was done by V. Ye. Blagodarov and N. F. Zhirkov (Bukhta Tiksi aerologists). from the timing mechanism for self-recorders,

2. The Board with a Set of Tools

The board with the set of tools should include a set of pliers, a set of files, soldering irons, etc.

3. The Stand for Preparing the ^{Radiosonde} ~~radiosonde~~

The ^{radiosonde} ~~radiosonde~~ can be ^{conveniently} ~~conveniently~~ prepared on a stand about 48 centimeters long, 25 centimeters wide, and 20 centimeters deep.

4. The Device for ^{Radiosonde} ~~Checking~~ Testing the Electrical Circuit of the ~~radiosonde~~

The electrical assembly of the ^{radiosonde} ~~radiosonde~~ is checked with the usual electric light bulb with two prongs. When the test prongs are shorted, ^a ~~the~~ ^{bulb} ~~lights~~. One prong is made like the pin of a radio tube (for connection with the housing) and the other is made in a strip with a clip for connection to terminal 36 (Fig. 1) on the commutator strip. It is best to use a flash-light ^{bulb} ~~bulb~~ to check the pressure comb because there is sometimes a thin layer of insulating material on this comb which ~~will~~ flash the bulb when checked with a high current. However, a tooth with this insulation will not close the plate circuit in ^(radiosonde) ~~operation~~. A bad contact can be easily discovered if the comb is checked with a low current.

CONFIDENTIAL
CONFIDENTIAL

-46-

CONFIDENTIAL
CONFIDENTIAL

- 46 -

*Radiosonde*5. Indicators for Tuning the Radiosonde Transmitter

Three types of indicators can be used at polar stations, namely: a) a "Micro" lamp; b) a thermocouple indicator; and c) a high-frequency indicator.

The "Micro" indicator lamp is the simplest to handle. The filament pins of the "Micro" are connected in the antenna; the ~~greater~~ ^{greater power} the ~~current~~ ^{power} delivered into the antenna, the greater the heating of the "Micro" filament. At a plate voltage of 45 volts, however, the ^{Micro only} ~~Micro~~ is ^{only} ~~only~~ a rough indicator, since delivery into the antenna is not ^(always) ~~always~~ sufficient to make the lamp glow. ^(other) The two indicators ~~to follow~~ are more sensitive.

The thermocouple indicator, whose schematic diagram is shown in Fig. 29, is a very sensitive indicator. The thermocouple TP-5 ^{or} ~~TP-5~~ TP-6 are connected in the antenna and connected to a galvanometer. The greater the power delivered to the antenna, the greater the galvanometer deflection. Using this indication, the transmitter is tuned to maximum delivery into the antenna and the counterpoise length required is selected.

Fig. 29. Schematic Diagram of Thermocouple Indicator

~~The indicator can be mounted on an ebonite panel with a wooden frame,~~ ^{is also used occasionally.}

A high-frequency indicator in conjunction with a "Micro" ² The advantage of a high-frequency indicator for polar stations is that it can be easily assembled from the parts which are always available at any station ^{making} ~~which is concerned with the launching of sondes.~~ ^{daily radiosondes.}

The schematic diagram of the high-frequency indicator is shown in Figs. 34 and 35. The indicator ^{uses} ~~operates on~~ a UB-107 tube (11). ^{When the} ~~is the cap-~~

CONFIDENTIAL
CONFIDENTIAL

- 47 -
CONFIDENTIAL
CONFIDENTIAL

plate and filament circuits are ~~switched on~~ ^{switched on}, the milliammeter 10, or galvanometer with the proper shunt, will indicate a plate current, whose magnitude will remain constant ~~for~~ ^{ant f} for the constant voltages of the plate and filament batteries. If, now, the taps of the ~~antenna~~ ^{tuned circuit} and ~~the antenna~~ ^{radio} antenna are connected respectively to terminals 4 and 5, the antenna current will increase the filament current, in turn producing a higher plate current, ~~which~~ ^{which} is recorded by the galvanometer 10. The greater the power delivery into the antenna, the greater the swing of the galvanometer needle. The transmitter can then be tuned by changing the inductance ^{inductance} (by moving the taps) and the capacitance (through the variable condenser) until maximum deviation of the galvanometer needle is obtained.

The chokes 12 are inserted so that the antenna current (r.f. current) will be blocked from the filament battery ~~very~~. The rheostat 13, used to regulate filament current, is placed between the filament battery and the chokes to prevent excessive losses of antenna current.

It is sometimes desirable to ~~connect~~ ^{connect} ~~close~~ the filament of a PT-2 lamp

Fig. 34. Schematic Diagram of the "Micro" in the circuit with the indicator tube. The transmitter can then be first tuned by the galvanometer with the "Micro" cut out, and then checked by the "Micro" with the galvanometer cut out.

CONFIDENTIAL

CONFIDENTIAL

-48-
CONFIDENTIAL
CONFIDENTIAL
-48-

6. The "Garf" Instrument

At large continental aerological stations, a special bell jar is used to check the pressure element. These units are also available at ~~some~~ some polar stations (Bukhta Tikhaya, for example). The majority of polar stations, however, use a Garf instrument, designed for testing altimeters, to test the pressure elements of meteorographs and ~~radiosondes~~ ^{radiosondes}.

Fig. 38. Diagram of the Garf Instrument

The instrument includes the following (Fig. 38): the chamber 1, a ^{pump} ~~pump~~ with hand or electric drive 2, a mercury manometer 3, a spare hand pump, a ^{wooden} ~~wood~~ housing for the chamber 4, a ^{wooden housing for} ~~wood housing~~ of the manometer, rubber tubes 5 and 6, and minor appurtenances (a flask with mercury designed for two manometers ^(holding) 875 grams ^(only) 65cc; a flask with glycerin ^(holding) 25 grams; ^{instructions} ~~instructions~~ for using the unit and the arrangement diagram, etc).

The chamber ~~of the~~ ^(instrument) is a ^{cylindrical} ~~cylindrical~~ iron vessel, divided into upper and lower parts by a ^{rigid} ~~rigid~~ horizontal partition. The instrument to be checked is placed in the upper chamber 7, while the lower serves to create additional vacuum. The chambers are connected by a small tube 9 to an overlapping valve 10. The upper chamber has four ^{lights} ~~lights~~ 11 for observations on the pressure ~~contact~~ arm of the instrument under test. The chamber is covered by a spherical lid and is drawn down by a screw 13 into a hinged rocker arm 14. There is a sleeve with a valve 17 in the lower chamber 8 for connecting the pump. In the upper chamber, the sleeve 18 is used

CONFIDENTIAL

CONFIDENTIAL

-49-

CONFIDENTIAL
CONFIDENTIAL

-49-

to connect the pump with the manometer 16, and the valve 19 connects the chamber with the outer medium (to admit air). The Goede oil pump is mounted with a hand drive ^{into} ~~into~~ one unit. Later pump models are equipped with an electric motor. The U-shaped mercury glass manometer has a scale for reading vacuums corresponding to heights from 0 to 18,000 meters.

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7 The RUB-4 Receiver

CONFIDENTIAL

CONFIDENTIAL

- 50 -
CONFIDENTIAL

7. The Receiver KUB-4

a. General Information

The short-wave receiver KUB-4 (Fig. 42) is used for reception of ^{radio} ~~radio~~ signals in almost all Arctic aerological stations. The KUB-4 is a four-tube ^{tuned} regenerative receiver using ~~straight amplification~~. The electromagnetic oscillations from the antenna enter the r.f. amplification stage, and then go directly (and not after preliminary ^{conversion} ~~transformation~~ of the ^{r.f.} ~~radio~~ frequency into an ^{i.f.} ~~intermediate~~ frequency, as is the case in superheterodyne receivers) into the detector stage. The low-frequency oscillations obtained ^{from} ~~after~~ the detector stage are amplified by two ^{a.f.} ~~audio~~ frequency amplification stages and enter the telephone, which reproduces the signals received on the antenna. This receiver belongs ^{to} ~~to the~~ regenerative ^{type} ~~type~~ because the detector stage is connected in a regenerative circuit with negative feedback. The KUB-4 is supplied from direct current sources. Its output power is 0.05 watt, which is sufficient to drive a low-power loudspeaker.

Fig. 42. ^{Overall} ~~General~~ View of the KUB-4 Receiver

The wavelength range of the receiver, equal to 10-200 meters, is divided into five frequency bands: I - 10-19 meters; II - 19-34 meters; III - 34-62 meters; IV - 62-112 meters; V - 112-200 meters.

The frequency bands are changed by ^{changing} ~~changing~~ the r.f. coils (Fig. 43) of two tuned circuits. Within each band, the receiver is tuned to various wave-

CONFIDENTIAL

CONFIDENTIAL

-51-

CONFIDENTIAL
CONFIDENTIAL

lengths by simply changing the capacitance of the tuned circuit, while the inductance remains constant. The capacitance of the tuned circuits (I and II) is changed by means of the variable condensers 4 and 10 (Fig. 44). The Vernier knobs of condensers 4 and 10 are furnished with pointers and scales with 100 divisions. (Fig. 42). Turning the knob to the left decreases the capacitance and ^{vice-versa} ~~to the right, increases it.~~

Each wavelength within a given frequency band corresponds to a definite scale division. Therefore, by graduating the scale, the receiver can be tuned approximately ^{to} the required wavelength by setting the pointer on the proper scale division ~~of the tuning scale.~~ The results of graduating the bands with respect to the tuning scale of band II is shown in Table 2. The same table can be used for determining the wavelength (with an accuracy of about 5%) corresponding to any value of the tuning scale in any of the five frequency bands. Starting with the reception of a station whose wavelength is known, the approximate tuning to the required station is determined ^{from} ~~according to~~ the table and the scale pointers of both circuits are set in this position. Finer tuning is done by ear.

Table 2 - Receiver Wavelengths

Degrees of Tuning Scale	Wave Length		Bands				
	I	II	III	IV	V		

Fig. 43. R.F. Coils of the
KUB-4 Receiver

CONFIDENTIAL

CONFIDENTIAL

- 52 -

CONFIDENTIAL
CONFIDENTIAL

To correspond with the number of bands, five pairs of r.f. tuning coils are attached to the receiver, four of which are set in a rack on the outer side of the cabinet top, while the fifth set is inserted in a block of the receiver.

The coils (Fig. 43) are wound on wooden frames with ebonite bases. The bases have four metal prongs to which the ends of the windings are connected. When the coils are inserted in the block designated for them, the windings are connected to the receiver circuit through these prongs.

Fig. 44. Schematic Diagram of the KUB-4.

Each frame has
~~Each frame has~~ two windings. For coils of tuned circuit I, these windings are: the upper winding is the induction coil 2 (Fig. 44) and the lower winding is the antenna coupling coil 1. For coils of tuned circuit II, the upper winding is also an induction coil 8, while the lower is the negative feedback coil 7. The distance between windings is fixed by a collar. The coils are inscribed with the number of the tuned circuit (I or II) and the frequency band for which they are intended.

b. The ^Electrical Circuit of the Receiver

The receiver KUB-4 has four stages (Fig. 44): the r.f. amplification stage, the detector stage, and two ^{r.f.} ~~audio frequency~~ amplification stages. *described*
This type of circuit is designated 1-V-2. The individual stages are ~~described~~ below.

CONFIDENTIAL
CONFIDENTIAL

- 5 -

CONFIDENTIAL
CONFIDENTIAL

The R.F. Amplification Stage. The electromagnetic oscillations received by the antenna are transmitted by means of inductive coupling (coils 1, 2, Figs. 44 and 45) into tuned circuit I of the r.f. amplification stage. The tuned circuit is connected ^{control} into the ~~grid circuit~~ ^{grid} of the tetrode 5B-147, and thus the voltage oscillations from the tuned circuit are ^{fed} ~~transmitted~~ to the grid ~~of the tube~~. The voltage oscillations on the ^{grid produce} ~~grid~~ cause plate current oscillations. Tuned circuit II, ^{the} ~~the~~ induction coil 3 and the ^{variable} ~~variable~~ condenser 10, are connected in the plate circuit and represent the tube's plate load.

The plate current oscillations create voltage oscillations across the terminals of this load which are in phase with, but greater in amplitude than, the voltage oscillations on the grid. Consequently, the voltage oscillations from tuned circuit I are amplified by the tube and "transferred" into tuned circuit II. The two tuned circuits provide good selectivity for the receiver. This type of r.f. amplification circuit is called a resonance amplification circuit with the tuned circuit in the plate (plate-tuning).

A tetrode, the 5B-147, is used for this stage, since triodes (UB-107, e, UB-100, and others) are ^{not suited} ~~unsuitable~~ for high-frequency ^{r.f.} amplification, just as tetrodes are ^{not suited} ~~unsuitable~~ for ^{s.f.} ~~audio frequency~~ amplification. In ^{in r.f. amplification} ~~radio~~ frequency ^{amplification} ~~amplification~~, it is very important to ^{eliminate} ~~eliminate~~ parasitic capacitative coupling between the elements of the grid and plate circuits. When these couplings are present, the plate circuit oscillations may be partially ^{self} ~~transmitted~~ into the grid circuit and cause "self-excitation" of the stage. The stage would then begin to generate ^{undamped} ~~undamped~~ ^{oscillations} ~~oscillations~~ of the frequency to which it was tuned. Parasitic coupling ^{can} ~~may~~ be caused by inter-electrode capacitance between the plate and the grid of the tube. The suppressor ^{grid} ~~grid~~ in the 5B-147 greatly ^{reduces} ~~decreases~~ this coupling if this

CONFIDENTIAL
CONFIDENTIAL

-54-

CONFIDENTIAL

grid is connected to the filament through a condenser having sufficient capacitance to pass ^{r.f.} ~~high-frequency~~ frequency.

The screen grid is connected to 40 volts, taken from the plate battery of the receiver. ~~The screen grid is grounded by connecting it to the ground-
ed filament.~~ In the SB-147, the plate is brought out to a can instead of to the ^{tube socket in} ~~vacuum tube~~ to eliminate parasitic couplings. The screen grid is connected to the plate pin. Within the tube, the screen grid, in the form of a small plate, is placed beneath the plate and serves to screen the plate from the holders ^{and} ~~and~~ the grid wires. This screen is supplemented by an external screen to screen the plate outside the tube. For this purpose, the tube is placed horizontal and passes through a hole made in a metal screen which, ^{more-or-less} ~~as a screen~~, continues the surface of the internal screen.

In order to obtain amplification of oscillations without distortion, the operating point of the tube must be on the middle ^{of the linear part} ~~of the characteristic curve~~ of the tube's characteristic curve. This is accomplished in the KUB-4 by applying a bias voltage of 2 volts to the grid.

To prevent the plate battery from short circuiting if the variable condenser 10 in tuned circuit II (Fig. 44) should breakdown, a fixed condenser 11 with a capacitance of 5500 micro-microfarads is ^{connected} ~~connected~~ in series with it. The blocking condensers 3, 6, and 9 with capacitance of ^{.011} ~~11,000~~ micro-microfarads are used in this stage to ^{eliminate} ~~eliminate~~ parasitic couplings through the supply circuit. The schematic diagram of this stage remains unchanged in the change from one frequency band to another.

The Detector Stage. Voltage variations in the plate circuit of the first tube (across the terminals of tuned circuit I) have two components; ~~namely, the r.f. oscillations component and the direct component (dead current).~~

CONFIDENTIAL
CONFIDENTIAL

-55-

CONFIDENTIAL

The Detector Stage. The KUB-4 receiver makes use of grid detection, i.e., the ~~radio frequency~~ ^{r.f.} is separated by ~~rectification~~ ^{using an} operating point on the bend of the grid current characteristic curve, ~~while simultaneously position-~~ ^{which operating point is also} ~~ing it~~ ^{linear} on the middle of the ~~straight~~ ^{linear} part of the plate characteristic curve.

From the plate circuit of the first tube, the oscillation voltage is fed to the grid of the detector 15 through the fixed condenser 12 (Fig. 44). The condenser prevents a terminal of the plate battery from being connected to the detector grid.

The oscillations entering the grid of the detector promote accumulation of electrons on the grid, which can decrease the plate current. To avoid this, a high ohmic resistance 13 (a Kaminskiy resistance of 1 megohm) is inserted, through which the ~~accumulating~~ ^{to} electrons can ~~flow~~ ^{leak} off. The voltage oscillations on the detector grid cause grid current oscillations, which in turn cause voltage oscillations on the grid resistance 13. These oscillations, entering the grid of tube 15, join with r.f. oscillations fed from the plate circuit of tube 5, which is operating under self-excitation conditions. The resulting ~~oscillations~~ ^{oscillations}, caused by two ~~voltages~~ ^{voltages}, ~~the frequencies of the signals received and the frequencies developed by the local self-excited oscillator (the tube 15),~~ are amplified by the tube (since the operating point lies on the middle of the rectilinear part of the plate current characteristic curve), and, ~~causing~~ ^{producing} plate current oscillations, are transmitted into the plate circuit of the detector.

As was previously mentioned, the detector stage uses a regenerative circuit and operates with a UB-107 tube, which is both a detector and amplifier (because the ~~capacitance~~ ^{capacitance} and resistance of the grid-leak circuit are so selected). The regeneration consists of the negative feedback between the plate and grid circuit of the ~~detector~~ ^{detector} 15, which is accomplished ~~by common~~ ^{by common} induction through ~~the~~ ^{the} negative feedback coil 7 with the

CONFIDENTIAL
CONFIDENTIAL

- 36 -

CONFIDENTIAL

cell 8. Regenerative ^{coupling} ~~oscillation~~ permits considerable amplification of the oscillations received from the plate circuit of the first tube ^{by} ~~through~~ ~~inductive transmission~~ ^{feeding} of the oscillations from the plate circuit into the grid circuit, ^(inductively) i.e., at the expense of ~~the~~ plate battery ^{energy}. Regeneration increases the sensitivity of the receiver considerably, since energy "transfer" from the plate into the grid circuit is ^{equivalent} ~~equivalent~~ to the ^{decreasing the} ~~decrease in~~ attenuation of the tuned circuit, and consequently a ^{sharper} ~~sharper~~ resonance curve is ^{ob-} ~~ob-~~ tained.

If the energy obtained from the plate circuit is sufficient to compensate for damping losses (very strong negative ^{feedback} ~~feedback~~), the grid circuit of tube 15 will be transformed into an oscillator of undamped natural ^(r.f.) ~~high-frequency~~ oscillations. The latter, ^(will be mixed) ~~mixed~~ with the radio-frequency ^{r.f.} ~~oscillations~~ received on the antenna and ^{produce} ~~gives~~ a beat frequency ^{frequency} equal to the difference of the frequency of natural oscillations and the frequencies received. The beat frequency after amplification is fed to the telephone and drives the membrane at audie frequencies.

If the knobs of the tuning circuits are rotated, the natural frequency of the tuned circuit is changed, i.e., the frequency difference is changed, which changes the pitch of the beat frequency tone in the telephone. When the tuning knobs are rotated to the right (increasing capacitance), the ~~the~~ frequency of natural oscillations decreases, and, if it is greater than the frequency of the oscillations received, the frequency difference decreases (approaching resonance), which gives a beat frequency with a lower pitch. Thus, when approaching resonance, a whistle with a decreasing pitch is heard. When the resonance point is passed, the pitch of the beat tone increases. This ^{fact} ~~circumstance~~ is usually used in practice in tuning to a given wavelength.

If ~~the~~ negative feedback is increased, the oscillations will be amplified ^{self-excited oscillation} ~~before generation~~ (up to the threshold of ~~generation~~). As seen as the

CONFIDENTIAL
CONFIDENTIAL

CONFIDENTIAL
CONFIDENTIAL

threshold is passed, the natural oscillations ~~existing~~ in the tuned circuit will be imposed on the received signals and the beat frequencies will be distorted.

~~The use of a telephone for reception of signals is not recommended in generation conditions. When the negative feedback is decreased so that maximum amplification, but not oscillation, remains. In the reception of radiotelegraph signals, on the other hand, generation conditions must be used, since the telegraph signals (Morse code, for example) could not be heard in the telephone without the natural oscillations, because the r.f. oscillations produced by the transmitting station's oscillator when the key is closed cannot produce sounds in the telephone. Being imposed on the natural oscillations, they will produce a beat frequency, which reproduces the dots and dashes received from the transmitting station in the telephone.~~

The negative feedback is regulated by changing the direct voltage on ~~the detector~~ ^{is regulated} plate. This plate voltage ~~is regulated~~ by changing the value ~~of the voltage~~ ^{used} across the resistance 20, which is connected in series in the plate circuit. For this purpose, an additional UB-107 (17) is ~~connected into the~~ ^{used} ~~circuit~~ ⁱⁿ of this stage. This tube is connected in the circuit so that its emission current passes through resistance 20 and creates an additional voltage drop across it, thus dropping the plate voltage of tube 15 still further. The greater the heating of the filament of tube 17, the greater its emission current and, consequently, the greater the voltage drop on the resistance 20 and the less the ~~plate voltage on the~~ ^{plate voltage on the} detector tube 15, i.e., the less the negative feed-back, and vice-versa. Thus, when the heating of the filament of tube 17 is increased, the negative feed-back is decreased, and vice-versa.

A rheostat 18 is placed in the filament circuit, whose arm is the knob of feed-back.

CONFIDENTIAL
CONFIDENTIAL

CONFIDENTIAL
CONFIDENTIAL

of negative ~~feed-back~~ regulation in the receiver. When the ^Negative feed-back knob is turned to the right, heating of tube 17 decreases and ~~fee-~~negative feed-back increases, and vice-versa. The letters M and B are above the knobs, indicating "small" and "large" negative feed-back.

This method of negative feed-back regulation causes non-productive expenditure of plate battery power and requires another tube in the circuit, but it is used nonetheless, because it produces ^{less} ~~the least~~ detuning of the receiver in negative feed-back regulation than any other method.

The fixed condensers 14 and 16 promote smooth and positive ~~introduction~~ ^{condenser} of negative feed-back and shorts (primarily ^{condenser} 16) the r.f. currents to the filament circuit. The ^{condenser} ~~condenser~~ 21 shorts the a.f. currents to the filament circuit and is ^{simultaneously} ~~also~~ a by-pass condenser which eliminates possible parasitic couplings through the supply circuit.

The plate current of the detector tube contains three components: the r.f. component, the ^{d.c.} ~~direct~~ component, and the ^{a.f.} ~~audio~~ component. The r.f. currents, as was indicated, are grounded through ^{condensers} ~~condensers~~ 14 and 15, since the winding of transformer 19 presents a very high impedance to them. The ^{d.c.} ~~direct~~ component and the ^{a.f.} ~~audio~~ component, on the other hand, pass through the primary winding of the transformer, but do not pass through condensers 14 and 15. Thus, the path of all three components of plate current in the plate circuit are separated. The a.f. component, passing through the primary winding of the inter-tube step-up transformer 19 is transmitted ^{inductively} ~~inductively~~ into the secondary winding, which ^{is} ~~is~~ connected in the grid circuit of the ²³ ~~subsequent~~ stage for the first stage of ^{a.f.} ~~audio~~ frequency amplification.

CONFIDENTIAL
CONFIDENTIAL

- 54 -

CONFIDENTIAL
CONFIDENTIAL

^{A.F.}
The ~~Audio Frequency~~ Amplification Stages. The first a.f. amplification stage ^{uses} ~~employs~~ a UB-110 tube (23) and is ^{resistance} ~~resistance~~-coupled to the following stage. The secondary winding of the inter-tube transformer (with a step-up ratio of 1:3) is connected in the grid circuit, and a Kaminskiy resistance (24) of 50,000 ohms is used as a plate load. The ^{a.f.} ~~audio frequency~~ oscillations fed to the grid of tube (23) from the plate circuit of the detector cause plate current oscillations which are in phase with, but greater in amplitude than, the corresponding oscillations on the grid. The plate current oscillations cause corresponding oscillations ^{across} ~~in~~ the terminals of the plate load (24). Through the condenser 26, which blocks the constant component of the plate current of ^{The UB-110} ~~tube 23~~, the a.f. oscillations which have been amplified by the first tube are transmitted to the grid of the UB-107⁽²⁷⁾, the tube employed in the second stage of a.f. amplification.

The grid resistor 25 is selected, as is the capacitance of (26), so that ^{UB-107} ~~tube 27~~ operates as an amplifier and not as a detector. Consequently, the a.f. oscillations are amplified further by ^{this} ~~the~~ tube ~~27~~ and transmitted into the plate circuit, whose plate load is the telephone (or a low-power loudspeaker). The a.f. component of the oscillations ^{produces} ~~causes~~ vibrations of the telephone membrane which correspond to vibrations of the microphone membrane at the transmitting station, i.e., reproduces the transmitted sounds. The ^{d.c.} ~~direct~~ component, passing through the telephone windings, can magnetize or demagnetize the permanent magnets in the telephone, in dependence upon the direction of current. To avoid demagnetization, polarity should be observed in connected the telephone (or loudspeaker).

Since the alternating and direct components of the plate current of the last tube 27 are not divided and the output jacks of the receiver have d.c. voltage on them, special care should be taken in working with the receiver to prevent short-circuiting of the plate battery.

CONFIDENTIAL
CONFIDENTIAL

- 60 -

CONFIDENTIAL CONFIDENTIAL

The output jacks together with the supply source are bypassed by the condenser 28. ~~The grid bias is taken from the output of the first amplifying stage, as well as the grid of tubes 3, are biased with a common source for the three tubes.~~ ^{are given} 2 volts ^{grid bias} taken from common source for the three tubes.

c. Construction of the Receiver

External Appearance. The receiver is placed in a welded iron box, which protects its assembly from mechanical injuries and is at the same time an external shield for the receiver. The outer surface of the cabinet is painted green. The overall weight of the receiver is 8 kilograms. The dimensions of the panel are 500 x 155 x 130 millimeters.

The top of the panel is hinged to the back wall and gives when open free access to the tubes and the plug-in coils of the receiver.

The receiver has three control knobs located on the front panel (Fig. 42). The control knobs are: a) a vernier knob for the variable condenser of tuned circuit I; b) a vernier knob for variable condenser of tuned circuit II; and c) a knob for regulating negative feedback.

A supply switch with off-on positions and the telephone jacks with the inscription "output" over them and an indication of the polarity of the d.c. voltage on the telephone ~~are also on the front panel.~~ ^{are also on the front panel.}

The antenna terminals A, the grounds Z, and the five ^{terminals} ~~terminals~~ for connecting the supply voltages are located on the back wall of the cabinet. The inscriptions -120, -4, 0, -2 over these terminals indicate the voltages connected to these terminals.

d. Conditions of Exploitation

Receiver Supply. The following batteries ^{required} ~~necessary~~ to supply the receiver: plate battery-120 volts; filament battery-4vvolts; bias battery-2 volts.

CONFIDENTIAL CONFIDENTIAL

CONFIDENTIAL CONFIDENTIAL

The plate battery also has a 40-volt tap. The maximum plate current of the receiver is 17 milliamps, and the maximum filament current, 400 milliamps.

Since the plate current is low, either low-capacity storage batteries or batteries made up of dry cells can be used as a B-battery. If dry cells are used, the battery should be by-passed by a condenser with a capacitance of 1-2 microfarads, since ^{otherwise} ~~otherwise~~ the receiver might ^{go into oscillation} ~~oscillate~~ because of the high internal resistance of the battery. The filament ^(battery) must have ^{capacity} ~~enough~~ of at least 20-40 ampere-hours.

Notes: 1. The receiver sensitivity is sometimes increased slightly if 60 volts is used instead of 40 volts on the screen grid of the 6X4 tube. The choice of the correct voltage ^{depends} ~~depends~~ upon the ^Q ~~quality~~ of the tube.

2. ~~Besides the normal voltage of 120 volts~~ voltages up to 160 volts can be used to supply the plate circuits. The voltage on the screen grid in this case should be raised to 60-80 volts.

The sensitivity of the receiver increases when the plates are overdriven. However, receiver operation is less stable and more power is drawn from the plate battery.

The Antenna. The KUB-4 receiver normally operates with an outside antenna of any type. As an average, the horizontal part should be 15-20 meters and the vertical part, 5-10 meters. The use of an indoor antenna is in general inefficient. It is not to be recommended in particular in houses with electric lights, where the antenna is especially susceptible to local noise.

Neither should the lighting circuit be used as an antenna.

Grounding. The receiver is ^(grounded by soldering the ground lead to) ~~grounded~~ a metal sheet 0.5 square meters in area to which the ground lead is soldered. The sheet should be buried in the ground, down to the ground water level (2 meters) if possible.

CONFIDENTIAL CONFIDENTIAL

- 42 -

CONFIDENTIAL
CONFIDENTIAL8. *Power Packs*
Supply Sources

Batteries made up of Leclanche cells, lead-acid batteries, and alkaline batteries are used as supply sources in radiosounding. Alkaline batteries have a number of advantages over ~~lead-acid~~ ^{lead-acid} batteries, and therefore have ~~been~~ ^{been} used ~~extensively~~ ^{extensively} recently. The batteries produced by the Saratov plant (Shgh42) is similar in construction to the "SI" type Jungner battery. The separate cells are ~~usually connected~~ ^{made up} into a battery in practice. Although the Saratov plant produces ~~ready~~ ^{finished} batteries, the major part of its production goes to the consumer in the form of individual cells. Therefore, below we give basic data on ~~the method of~~ assembly of batteries according to standard requirements (Table 4). Batteries of different types are distinguished by their external appearance, as well as by their voltage and capacity. There are batteries in wooden cases with ~~wooden~~ covers on hinges and batteries in ~~wooden~~ ^{wooden} cases with individual covers (special form M). In batteries with capacity of 10 ampere-hours, the wooden case is replaced by lathing without covers and handles.

Table 4-Characteristics of Storage Batteries

Type of Battery	No of Cells in a Battery	Nominal Voltage	Nominal Capacity, ampere-hours	Dimensions			Weight of Battery with Electrolyte, kg
				Length	Width	Height	

32AKN-2.25M
64AKN-2.25
10NKN-22M
17NKN-22
4NKN-4.5
4NKN-4.5
5NKN-4.5
6NKN-4.5M
7NKN-4.5M
8NKN-4.5M
10NKN-4.5
4NKN-60M
5NKN-60
7NKN-60M
10NKN-60M
4NKN-100M
5NKN-100M
10NKN-100M
10NKN-100
4NKN-100
4NKN-100
5NKN-10

CONFIDENTIAL
CONFIDENTIAL

-63-

~~CONFIDENTIAL~~
~~CONFIDENTIAL~~

The battery types are ^{named} ~~designated~~ according to a general principle for alkaline batteries, namely: the number before the designation ^{gives} ~~the~~ the number of cells connected in series in ^{the} ~~a~~ battery, next the letters AKN (plate-cadmium-nickel) or NKN (filament-cadmium-nickel), then the numbers indicating the ^{capacity} ~~capacities~~, and the letter M for batteries with ^{special} ~~special~~ external appearance (cases of special form).

The following arrangement of cells in batteries is accepted: for 4-5 cells, in one row; for 17-32 cells, in two rows; 48 cells, in 3 rows; and 64 cells, in 4 rows.

The basic rules for maintenance and exploitation of alkaline batteries are ^{given} ~~stated~~ in "Instructions on the Maintenance of Alkaline Cadmium-Nickel Batteries" (reference 21 in Bibliography).

^{Instructions on the Maintenance} 9. In ^{Storage} ~~Instructions on the Maintenance of Alkaline Cadmium-Nickel Storage~~
Batteries

After the electrolyte is established at the normal level, the batteries are put on charge. The batteries are charged by normal charging current (Table 5) for 6 hours, then by half the normal charging current for 6 more hours, and then discharged by normal discharge current for 4 hours. This charge-discharge cycle is repeated 2-3 times. The batteries may then be put into ^{operation} ~~use~~.

Table 5 - Characteristics of Various Types of Storage Batteries

Battery Type	Nominal Capacity, amp.-hour	Normal 7-hour Charging Current, amp.-hour	Normal 8-hour Control Cycle Charging Current, amp.-hour	Amount of Electrolyte for one Battery, Liters	Weight of Battery with Electrolyte, kilograms
--------------	-----------------------------	---	---	---	---

AKN-2.25
NKN-10
NKN-22
NKN-45
NKN-50
NKN-100.
2-PKN

~~CONFIDENTIAL~~
~~CONFIDENTIAL~~

- 64 -

CONFIDENTIAL

A few drops of vaseline oil are usually poured in each battery to prevent the electrolyte from absorbing carbon dioxide from the air.

There are two types of electrolytes for alkaline storage batteries, i.e., winter and summer. The summer electrolyte consists^{5/6} of a solution of caustic soda in water with a density of 1.17-1.19 (21-23°) and are used for temperatures of the surrounding air from 10°C and above. ^{The} ~~The~~ winter electrolyte consists of a solution of caustic soda (ST-1872 GOKhP) in water with densities dependent upon the temperature: from -15 to a -10°C, density of 1.27-1.30. In extreme necessity, when no caustic soda is available, a solution of potassium hydroxide with specific gravity of 1.18-1.19 can be used as the electrolyte in the summer. If this is done, the batteries should be charged at night if possible, kept in the shade in the daytime, and ^{should} ~~should~~ not be put on the warm earth.

10. Instructions on Restoring the Capacity of Alkaline Cadmium-Nickel Batteries
Batteries Which Have Lost Up to 25-40% of Their Capacity in Exploitation with Elec-
trolyte From a Potassium Hydroxide Solution

^{Batteries whose capacity} ~~In batteries whose capacity~~ has dropped 25-40% below rated ^(capacity) in exploitation ~~using~~ ^{with} an electrolyte from a potassium hydroxide solution, ~~the capacity~~ ^{it} can be restored by ~~replacing~~ substituting an electrolyte using a caustic soda solution. Control tests of all ⁶ batteries, both those in use and those on the shelf which have outlived their usefulness, must be made to find the batteries whose capacity has dropped ^{sharply} ~~sharply~~. The control tests are made in the following way:

First cycle. The batteries are put under quick charge (6-hour normal current and 6-hour half) and discharged ~~under~~ ⁸ under normal 8-hour conditions to a voltage of 1.0 volt on the terminals of each battery.

Second cycle. Charging for 6 hours under normal charging conditions, and discharge under normal 8-hour conditions to a voltage of 1.0 volt on

CONFIDENTIAL

CONFIDENTIAL

-65-
CONFIDENTIAL
-65-
CONFIDENTIAL

the terminals of each battery. The capacity of each battery is determined from the data of the second cycle. Batteries delivering less than rated capacity on the control cycle (~~within the limits of 10%~~) should be selected to have their capacity restored. The electrolyte of the batteries selected for restoration should be poured out; they ^{should} ~~then~~ then be washed 2-3 times with distilled water, and then filled with a solution of caustic soda with a specific gravity of 1.17-1.18. They are then left for two hours so that the new electrolyte can penetrate into the plates; after which they are given two quick charges (7-hour normal current and 6-hour half normal current). After each of these charges, the batteries are discharged under normal conditions for 8 hours, but not ~~below~~ below 1.0 volts on the terminals of each battery. After two cycles with quick charges, the first new electrolyte is poured out of the batteries and a ^{again replaced} ~~second~~ replacement ^{by} ~~with~~ a caustic soda solution of the ~~same~~ ^{electrolyte} specific gravity is made. The ~~electrolyte~~ of the first replacement should be saved and used ~~as a~~ ^{as a} "summer electrolyte". After a second change of the electrolyte, the batteries should be given two quick charges and discharges, ^{then} ~~then~~ a normal 7-hour charge and a control discharge under 8-hour conditions to a voltage of 1.0 volt on the ^{Terminals} ~~terminals~~ of each battery, after which the batteries, with their capacity now restored to rated or not less than 85% of rated, are put into exploitation.

11. ^{The} ~~The~~ Charging-Distribution Switchboard

The batteries are charged and their ^{power} ~~power~~ distributed through the charging-distribution switchboard, which must satisfy the following requirements:

- 1) simply and conveniently switch the batteries on charge and on operation; 2) ~~show~~ indicate the voltage of each battery and the voltage at the

CONFIDENTIAL

CONFIDENTIAL

- 66 -

- 66 -
CONFIDENTIAL

output terminals; 3) indicate the charging current; 4) prevent the batteries from short-circuits; 5) easily change the voltage of a filament battery; and 6) when ~~need required~~ ^{necessary}, change the resistance of the charging circuit to allow for the proper current in charging batteries.

To construct such a switchboard, an ebonite (or other insulator) board of dimensions approximately 50 cm x 50 cm is taken and the following equipment mounted on it: a) two-way knife switches; b) a voltmeter with a shunt and transfer switch, c) an ammeter, d) ~~fuses~~ ^{fuses}, d) a 50-ohm rheostat, and g) rheostats in the charging circuit of the filament and plate.

Fig. 48. Schematic Diagram of the Charging-Distribution Switchboard for Arctic Aerological Stations

The positive poles of two plate batteries are connected to the knives of knife-switches 1 and 2 (Fig. 48), while the plus of the filament battery is connected to knife 4. Plus of the network is connected to the upper ter-

CONFIDENTIAL

CONFIDENTIAL

- 67 -

CONFIDENTIAL

CONFIDENTIAL

minals of these knife-switches through a ~~switch~~^{rheostat}. The negative poles of the batteries are connected directly to the common minus, except for one plate battery minus, which is connected to minus of the network through a knife of switch 3. This is done so that when the switch is "down", i.e., when the batteries are switched on operation, both batteries can be connected in series (to obtain ¹⁶⁰~~150~~ volts). To accomplish this, the lower terminals of the 2nd and 3rd switches, i.e., the plus of the first and the minus of the second plate battery, are jumpered. The lower terminals of knife switches 1, 2, and 4 are connected to the output terminals, from which plus or minus 160, 80, and 4 volts can be obtained. Thus, by throwing the knife-switches up, we put all batteries in the network on charge, and by throwing them down, we supply voltage to the output terminals, from which the supply for the receiver and other equipment is taken.

A voltmeter 5 is installed in the center of the board to ~~measure~~^{measure} the voltage of the batteries, the minus of which is connected to the common minus, and the plus to either the plus of the plate or the plus of the filament battery through the switch 6. The ammeter 8 is connected in series in the network and records the charging current. The fuses 9 are selected for maximum ^{charging} discharge current and the fuse 10 for maximum discharge current.

There is a rheostat 11 in the discharge circuit of the filament battery to regulate the filament battery voltage. Since charging is done from the network ^{for other}~~for other~~ supply sources whose voltage is higher than that of the batteries, the rheostats 12 and 13 are connected in the charging circuit of the plate and filament batteries to drop the excess voltage of the battery. ~~Electric~~^{resistance} lights of varying ~~resistance~~^{rheostats} are often used as ~~resistors~~.

The switchboard described above is very simple and can be used at stations where there is only one radio receiver. At larger stations (producing

CONFIDENTIAL

CONFIDENTIAL

- 68 -

CONFIDENTIAL
CONFIDENTIAL

~~radio receiver~~
daily ~~receives~~), there is also a spare (emergency) radio receiver with separate supply and antenna. There should not be a common minus on the switchboard, since these two receivers must be isolated.

~~An example of the~~ switchboard used for this type of station is illustrated by the one used at Bykhta Tiksi (Fig. 49). In this switchboard, there is a double-pole, double-throw knife switch for each battery instead of a single-pole, double-throw. The pluses and minuses of the batteries are fed to the knives of the switches, while the plus and minus of the line ~~are~~ ^{are} connected to their upper terminals. In addition, there are more terminals on the transfer switch 6, to which is supplied the plus of the line and the plus of the outputs 160, 80, and 4 volts, which are connected with the plus of the voltmeter through a sliding contact and the shaft of the switch. The minus of the line and the minus from the outputs ¹⁶⁰~~160~~, 80, and 4 volts, which are fed to the terminals connected with the minus of the voltmeter through two jumpered contacts on the sliding contact, are ~~fed~~ ^{fed} to the lower series of terminals of the transfer switch. By connecting the voltmeter through the sliding contact of the switch 6 into the line or onto the 160 volt output, etc., we can read the voltage of the line, of the batteries on the 160 volt output, etc.

The voltage at the terminals of each battery can be measured separately by connecting it in the line (the knife-switch of the battery is thrown up) with the line switched out. Then, when the sliding contact of the switch 6 is set in the "Line" position, the voltmeter shows the ^(battery) voltage of ~~the bat-~~ ^{tery} instead of line voltage.

In addition to the supply, telephone lines and signalling equipment can be ^(connected) ~~fed~~ to the switch-board. The spare jacks 18 from the line are inserted in the bottom of the line, have the rheostat 12 in their circuit, and are used to charge portable batteries, spare batteries, etc.

The connections to the automatic siren, which operates if the observed

CONFIDENTIAL
CONFIDENTIAL

- 69 -

~~CONFIDENTIAL~~
CONFIDENTIAL

Fig. 49. Schematic Diagram of the Charging-Distribution Switch-board and Signalling Equipment at the BURKE TIKI Polar Station

CONFIDENTIAL

- 70 -

CONFIDENTIAL
CONFIDENTIAL

is late, are shown in the diagram of the switchboard (Fig. 49). If the observer is on time, the siren does not operate, since the observer switches it off by throwing the transfer switch 15 before going out to the meteorological square, which simultaneously energizes the electric light illuminating the barometer.

When the switch 15 is positioned to the right, the supply the buzzer is connected ~~through~~ from the primary clock through the relay. The buzzer signals are transmitted on telephone lines every minute. These signals are used to synchronize the readings for base observations. When the transfer switch 16 is positioned to the left, the current is fed from the line to the siren.

If the station does not have an electric clock or a relay, contacts can be made on table clocks which ^{to} ~~will~~ open and close the buzzer supply. A sound generator can be constructed if there is no buzzer and sound-powered telephone. As an example of such a sound-generator, the diagram of one used

Fig. 51. Diagram of Sound Generator for a Contact Clock
~~at the~~ ^{at the} Bukhtalikhaya polar station is shown in Fig. 51.

12. Telephones

The schematic diagram of the sound-powered telephone is shown in Fig.

52. The set consists of the following main parts: a) a tube with the telephone, microphone, and switch (jack); b) the buzzer with a push button; c) ^{a transformer} ~~a transformer~~; ~~d) a transformer~~; g) a condenser; and f) terminals for connecting the supply.

In the sound-powered telephones, the microphone circuit is opened and closed by the jack, which is ^{located} ~~located~~ inside the handle of the telephone tube. In conversation, the valve must be pressed, which closes the microphone circuits. ~~As seen from the diagram, the primary winding of the~~

CONFIDENTIAL

CONFIDENTIAL

-71-

CONFIDENTIAL

~~set is connected to the battery,~~

Ringing in these sets is done ~~with the buzzer~~ by pressing the button K.

Fig. 52. Schematic Diagram of the Sound-Powered Set (UNA F-31)

~~This~~ ^{the} connects the primary winding of the buzzer to the battery and the secondary winding to the line. The current oscillations in the primary winding of the buzzer, caused by ~~the~~ vibration of the contact strip, are transmitted ~~into~~ ^{inductively} into the secondary winding of the buzzer, which is connected in the line.

The telephone set of the neighboring point is connected in the line. Therefore, when the button K is pushed, we ~~hear~~ ^{hear} the buzzer in this set (caused by ~~the~~ vibration of the contact strip in the primary winding of the buzzer of our set), and in the neighboring set the same buzzer tone will be ~~transmitted~~ ^{transmitted} to the telephone membrane. The pitch of the buzzer is regulated by a screw which ~~is brought~~ ^{is} outside the set. The buzzer of the ~~sound-powered~~ ^{sound-powered} set can be used to transmit the signal from which angle readings are made to the aerological points. To do this, the secondary winding of the buzzer is always connected to the line by connecting the contact strip 5 to the strip 8, and the contact clock is ~~also~~ ^{is} connected in the circuit of the primary winding of the buzzer. In practice, this ~~is~~ ^{is} done by connecting two conductors to the clock, one from the plus of the battery and the other from the primary winding of the buzzer. The clock closes the ~~signal~~ ^{circuit} through def-

CONFIDENTIAL
CONFIDENTIAL

- 72 -

CONFIDENTIAL
CONFIDENTIAL

inite time intervals (usually 1 minute), ^{providing} ~~receiving~~ signals ^{at} ~~in the~~ ^{Telephones} ~~of both points.~~

When the ring is made, the tube is picked up in the next receiver and the jack pressed, thus closing the microphone circuit. The current from the positive terminal of the battery passes through the winding of the transformer into the jack, then in the contact screw of the microphone, through the carbon powder into the minus of the battery. The current ~~vib-~~ oscillations in the microphone produced by the changing pressure on the carbon powder ^{are} transmitted inductively into the secondary winding ^{of} the transformer. The latter is in the line ~~circuit~~ and thus these oscillations are transmitted to the line. ~~Thus~~ ^{Therefore} the sounds produced by the microphone of the telephone tube of the neighboring set will be heard in our set. ^(the conversation) When ~~conversation~~ is completed, the jack is released, breaking the ^{micro-} ~~micro-~~ ^{phone} ~~phone~~ circuit (battery circuit).

^{Another} ~~Another~~ type of phone, ^{The} a magneto hang-ring set, other wise similar to the sound-powered set, is also used.

B. The ^RRoom for Processing Aerological Observations

The plan-diagram of this room is shown in Fig. 21. This room should have a separate entrance, i.e., should not be entered through the ^{room} ~~room~~ for preparation and reception. There should be two conveniently situated tables, one for processing ^{radiosonde} ~~radiosonde~~ signals and one for processing pibal observations. There should also be a cabinet for clean blanks, materials for processing ^{radiosonde} ~~radiosonde~~ observations, and records.

The table for processing ^(radiosondes) ~~radiosondes~~ should be equipped with the following ~~items~~: a) a handbook on radio sounding for Arctic aerological stations; b) a ^{collection} ~~collection~~ of tables and nomograms; c) two slide rules (25 and 50 centimeters long); d) adding machine, French curves, pencils, etc. The

The table for processing ^{pibals} ~~pibals~~ observations should be equipped with all necessary data ^{specified in} ~~according to the directions of~~ the Handbook.

CONFIDENTIAL
CONFIDENTIAL

- 73 -
CONFIDENTIAL
CONFIDENTIAL

~~Chapter II. Equipment of a First-Rank Arctic Aerological Station~~

Section 2. The Aerological Pavilion

A. General Information on the Equipment of an Aerological Pavilion in the Arctic

In many polar stations, the aerological pavilions, ^{radioisotope} ~~unfortunately~~ are not equipped to fulfill work in the launching of ^{radioisotope} ~~resonator~~ and pibals and in the production of hydrogen. This ^{is upon} ~~is~~ not only reflected in the quality of aerological observations, but contradicts the basic requirements for labor protection.

Figure 66 shows the plan-diagram of a typical aerological ^{pavilion} ~~pavilion~~ for polar stations which should serve as a guide in the construction of new or the re-equipping of old ^{pavilions} ~~pavilions~~. The pavilion is divided into four rooms for the following purposes; for heating water, for storing and ^{repairing} ~~repairing~~ envelopes, for ~~production of~~ gas-generation, and for filling ^{radioisotope} ~~radioisotope~~ and pibal ^{balloons} ~~envelopes~~.

Fig. 66. The Plan-Diagram of an Aerological Pavilion for Polar Stations

The space for heating water must be isolated from the gas-generation space to prevent the fire from the stove from entering the latter. It is expedient to have a tank for water built into the stove (1). There is also a locker (2)

CONFIDENTIAL
CONFIDENTIAL

- 74 -

CONFIDENTIAL
CONFIDENTIAL

in this room. The Bushev gas generator is installed in the gas-generation room. N. F. Zhirkov, aerologist of the Bukhta Tiksi polar station, made a special staging (5) with an envelope (Fig. 67) for a solid and convenient installation of the gas generator. The latter permits the water released from the gas generator chamber to flow along a gutter to the back of the pavilion, where a hole is dug for drainage; this provides for cleanliness and upkeep of the floor in the gas generator room. This staging is very convenient in practice, and it should be used at other stations.

In the gas-generation room, there is also a first aid kit (7), a storeroom for ferrosilicon (8) and a bench (6) for ^{cleaning} ~~cleaning~~ and maintenance of the gas generator tank after production of gas generation. There is a hole to the left of the generator through which a hose passes into the next room. One end of the hose is connected ^{to} ~~with~~ the gas generator and the other is put on the appendix of the ^{balloon} ~~envelope~~ to be filled.

The room for filling ^{balloons} ~~the envelope~~ has two wide double-wing doors for carrying out the ^{radiosonde} ~~radiosonde~~ envelope filled with hydrogen. The door ~~which is~~ used depends upon the wind direction. A net is stretched beneath the overhead in this room to prevent the balloons from hitting against the overhead and possibly breaking when they are torn out of the hands. In this room, there is also a table with weights (or counterweights) to determine the lift of the balloon; there are ^{also two} ~~also two~~ or three balloons with hydrogen to fill pibal envelopes or add to ^{radiosonde} ~~radiosonde~~ envelopes (when the amount of chemicals in the generator does not ^{yield} ~~yield~~ sufficient hydrogen to fill the balloon).

In the same room, there is also a gas-holder with a pump (Fig. 68), which can replace balloons or serve for collection of hydrogen if generation is conducted on the evening before the flight, instead of just before it. This

CONFIDENTIAL

CONFIDENTIAL

-75-

CONFIDENTIAL
-75-
CONFIDENTIAL

Fig. 67. Installation of the Bushev Gas Generator at the Bukhta Tiksi Polar Station (N. F. Zhirkov's Photo)

Fig. 68. Gas-Holder for Hydrogen Storage, Prepared at the Bukhta Tiksi Polar Station (N. F. Zhirkov's Photo)

is done because the hydrogen obtained from the gas generator always contains a considerable amount of water vapor. If the ~~envelope~~^{balloon} is filled with this hydrogen and stored for a period in freezing weather, the water will freeze on the inside of the ~~envelope~~^{balloon}, causing the latter to lose its elasticity and reducing its quality in flight. Moreover, the ~~envelope~~^{radiosonde balloon} sometimes bursts when being filled directly from the gas generator. Since frequently there is not enough time for a new filling, the launching time must be postponed.

To avoid this, hydrogen from the gas generator at some polar stations (I. I. Tsarev at Anadyr) is passed into a gas-holder, and then transferred with the help of a pump into the ~~envelope~~^{radiosonde} before launching. To illustrate, we cite the method of transferring hydrogen used at the Bukhta Tiksi polar station. This gas-holder can be made from two ~~envelopes~~^{radiosonde balloons}. No 100, by ~~putting~~^{putting} one inside the other through the appendix. The hydrogen can be transferred from the gas-holder into the envelope with the help of a pump from a rubber launch ~~or~~^{or} with the help of another pump having a suction

CONFIDENTIAL

CONFIDENTIAL

-76-

CONFIDENTIAL

valve (connected to the gas-holder) and a pressure valve (connected with the ~~balloon~~^{balloon} envelope to be filled).

The pavilion has an annex containing a storeroom for caustic soda (10), a storeroom for ice and snow (11) and a tambour (13) in which the ~~candles~~^{candles} for pibal lanterns should be lit for night launchings of pibals or rasondes. A net ~~should~~^{should} be stretched in the tambour, which also serves as a hall for entry into the gas generator room, where the balloon can be ~~supported while~~^{supported while} the candles are lit. This will free the aerologists hands to light the candles and fasten on the lanterns. The flat roof of the annex supports the primary point for pibal base observations. The ladder (14) serves for ascent to the primary point of the base.

An aerological ~~station~~^{pavilion} similar to the one described above has been construction at the Bukhta Tiksi polar station; it is shown in Fig. 69.

Fig. 69. The Aerological Pavilion at the Bukhta Tiksi Polar Station (N. F. Zhirkev's Photo)

As the foregoing shows, the aerological pavilion is basically ~~intended~~^{intended} for the production of hydrogen with the help of the Bushev gas generator and the filling of pibal and rasonde envelopes.

The production of hydrogen is ~~one~~^{very} ~~very~~^{laborious} ~~labor-consuming~~ and ~~dangerous~~^{rous} work for the polar aerologist. The Bushev gas generator has a number of defects, and each aerologist attempts to overcome these in his own way. The experience of aerologists with the Bushev gas generator and ~~methodical~~ studies

CONFIDENTIAL**CONFIDENTIAL**

- 77 -

CONFIDENTIAL
- 77 -
CONFIDENTIAL

in 1943/44 at the Bukhta Tiksi polar station permit a number of practically valuable instructions with respect to the process of Hydrogen production and the elimination of certain defects of the Bushev generator. A detailed description of the Bushev gas generator ^{and} the process of producing hydrogen under Arctic conditions with the help of this generator is given in the next section.

B. The Production of Hydrogen

1. The Method of Obtaining Hydrogen

~~For daily radiosounding and launching of two balloons~~, about 5 to 6 cubic meters of hydrogen is expended per day, i.e., about 2,000 cubic meters per year, ^{in launching one radiosonde and two balloons per day.} The delivery of such an amount of hydrogen to the Arctic, taking the considerable weight of the balloons and their scarcity into consideration, is very difficult, although the production of hydrogen under industrial conditions is not expensive. Given correct organization, hydrogen can easily be ^{produced} ~~produced~~ at the place where it is required. This requires ferrosilicon, or an aluminum-silicon alloy, caustic soda, and water. There are three types of ferrosilicon with respect to the silicon content ~~in it~~, i.e., 90%, 70%, and 45%. The latter is not suitable for hydrogen production because of its low silicon content.

Fig. 70. Diagram of the Process of Hydrogen Generation

A sample method of obtaining hydrogen is shown in Fig. 70. If in a vessel, ferrosilicon, caustic soda, and hot water are placed in a ratio of approximately 1:2:4, a chemical reaction will take place and hydrogen will be

CONFIDENTIAL
CONFIDENTIAL

- 79 -
CONFIDENTIAL
CONFIDENTIAL

liberated according to the following equation:



The hydrogen ^{liberated} ~~separated~~, rising upward and passing through the connecting tube, passes into the lower part of the vessel B. The latter is approximately 3/4 full of cold water; the hydrogen, passing through the water is cooled ⁱⁿ ~~and~~, ^{risks to} ~~rising, enters~~ the opening V and passes through the hose G into the balloon. This simple method, however, ^{yields} ~~gives~~ only a small amount of hydrogen. Special

large gas generators must be utilized to obtain considerable amounts of hydrogen.

> Insert Chart on Amounts Required For 1 m³ of Hydrogen
There are several types of gas generators, all of which ^{have} ~~have~~ their advantages and disadvantages.

Polar stations produce hydrogen with the help of the Bushev gas generator, constructed at the Bukhta Tiksi polar station in 1937/38. The construction and use of the Bushev generator is described in the next section, along with a method of generation which has justified itself in many years of exploitation by polar aerologists at Bukhta Tiksi.

2. The I. M. Bushev Gas Generator

a) Construction of the Gas Generator

The gas generator is divided into two main parts (Fig. 71): 1) the generator part, similar to the vessel A in ^{Fig.} ~~Fig.~~ 70, where the chemicals are inserted and the reaction takes place, and 2) the cooling part, ^{similar} ~~similar~~ to the vessel B, for cooling ^{hydrogen} ~~hydrogen~~ and collecting the condensation products.

The generator

Fig. 71. Diagram of the Construction of the Bushev Gas Generator

CONFIDENTIAL
CONFIDENTIAL

-79-

CONFIDENTIAL
CONFIDENTIAL

The generator part is a cylinder open from the bottom. In generation, ~~of the generation chamber~~, the tank (2) with chemicals, is inserted ~~at the~~ bottom. A circular asbestos lining 5 in the form of a ring is placed between the flange rings of the generator 3 and the generator chamber 4. If this is not available, an interwoven multi-strand cord of diameter 2 to 4 centimeters can be used. The clamp belts (7) are suspended in the brackets (6), on which are screwed the wing nuts (8), which serve to fasten the generator flanges and the generator chamber. Two grids (10) with handles (10a) and 3-millimeter notches along the edges are set upon the supports (9) inside the cylinder. The grids hold back the foam liberated in the reaction.

A manometer (11) with a safety valve (12) is installed outside the cylinder towards its upper part. The manometer and safety valve are mounted on a pipe (13) which passes inside the generator. There is a three-way stopcock (14) for the manometer and safety valve. A nipple (15) is welded onto the upper wall of the cylinder, on which the tank (16) ~~with the~~ ^{cock} stopcock (17) for pouring hot water into the generator is screwed.

A bell (18) with a rubber lining inside is screwed on the top of the water tank. A lead lining is inserted between the nipple and the pipe of the tank. On the side opposite the manometer, ^{There is a} ~~in the side~~ hole in which a gas pipe (19) is inserted and welded. The gas pipe is ^{fastened} ~~connected~~ to the connecting pipe (21) with the call (pipe with nut (20)). There is an asbestos lining between the nut and the connecting pipe. There is a control plug (22) on the end of the connecting pipe, permitting cleaning of the pipe when necessary.

The condenser consists of the cylinder (23), which is divided into two parts by the partition (24): the upper part (25), cooling the hydrogen, and the lower part (26), collecting the condensation products. There is a hole

CONFIDENTIAL

-80-

CONFIDENTIAL CONFIDENTIAL

(27) in the upper part of the cylinder for ^{draining off} ~~drainage~~ the water which has heated during generation and another hole (27a) for drainage of all water after generation. The ~~coil pipes~~ ^{the} outer (28) and inner (29) are inside the cylinder in its upper part. The coil pipes at the top enter the connecting pipe (21) and their other ends pass through the partition (24) into the bottom drainage chamber (26). There is a hole (30) with a stopper (31) for ^{at} ~~the~~ bottom of the chamber for drainage of the ^{condensation} ~~condensation~~ products. At the top of chamber (26), there is a hole with a pipe (32) in which the hose passing hydrogen into the ^{balloon} ~~chamber~~ is inserted. Both cylinders of the gas generator are connected firmly by the flanges (34) and stand on the legs (33).

b) Advantages and Disadvantages of the Bushev Gas Generator

The advantages of the Bushev gas generator include: 1) simplicity of construction and 2) convenience in cleaning the reaction residue and insulating without a water pipe (by snow, which is very valuable in the Arctic).

The disadvantages of the gas-generator are:

- 1) the manometer and the safety ^{valve} ~~valve~~ frequently stop up ~~and do not operate~~;
- 2) the brace bolts wear very rapidly;
- 3) the generator chamber is hard to lift;
- ^{gas escapes through} 4) the lining between the flanges of the generator chamber and the generator ^{this lining} ~~pass gas and wear out~~ rapidly;
- 5) the use of the stopper 30 instead of a ^{spigot} ~~spigot~~ makes drainage of water inconvenient, since the water falls into the hands and freezes;
- 6) there is no water gauge in the upper tank, and thus the amount of water entering the generator cannot be determined;
- 7) the manometer pipe (13-Fig. 71) is bent upwards and frequently gets clogged up, making the manometer and the safety valve useless.

CONFIDENTIAL CONFIDENTIAL

- 81 -
CONFIDENTIAL- 81 -
CONFIDENTIAL

c) Methods of Eliminating Defects

The aerologists of the polar station of Bukhta Tiksi proposed the following methods of eliminating these defects:

- 1) Insertion of a thick glass or ^{plastic} ~~plastic~~ strip with divisions into the wall of the tank.
- 2) The safety ^{valve} ~~valve~~ should be made with a larger hole, and not of the spring, but of the balance type, i.e., pressed from above by a lever with a load. The manometer can be left as ^{it} ~~is~~ is, but should be lifted higher by a special pipe.
- 3) The brace bolts should be bigger.
- 4) A mechanism ^{which} ~~which~~ might be used for lifting the tank is a ordinary lever, one end of which rests on the generator chamber, while the other is pressed with the feet while the chamber is guided with the hands.
- 5) Grooves should be cut in the generator flanges and the chamber flanges for the lining.
- 6) The stopper (30) can be replaced by a cock or set up on a lever and spring device.
- 7) The manometer pipe ^(should be) ~~to~~ set at an angle to the generator so that the ^{clogging} ~~clogging~~ mixture can flow downwards.

Experiment has shown that if the operating rules are observed and these defects are eliminated, the Bushev gas generator is quite ^{satisfactory} ~~satisfactory~~ for hydrogen production on the spot under Arctic conditions.

Section 3. Equipment of the Place Where ^{Radiosondes} ~~Radiosondes~~ are Checked and Launched

The place where ^{radiosondes} ~~radiosondes~~ are checked and launched should be located close (5-7 meters) from the aerological pavilion, where the envelopes are filled, and should be isolated from various types of cables, antennas, etc.

CONFIDENTIAL

CONFIDENTIAL

- 82 -

~~CONFIDENTIAL~~
CONFIDENTIAL

The instrument, before launching (especially in the warm season, ~~when there is sunbathing~~ and in high winds) should be checked in a psychometric booth designed for this purpose. The booth also contains a blower (Fig. 74) for ventilating the ~~radio~~ ^{radio sound} elements. Ventilation is particularly necessary ~~in~~ ^{on} clear, ~~some~~ ^{cool} days, when the temperature element will indicate a slightly high gradient and a slightly low temperature.

A ~~column~~ ^{post} 6-7 meters high is installed next to the booth opposite to the door through which the instrument is inserted. A block (or brace) is placed in the upper part of the column. Twine with a weight on one ~~end~~ ^{end} is thrown over this block; the other end of the twine is wound on a nail in the lower part of the column at shoulder level. When the ~~radio~~ ^{radio sound} is ~~set~~ ^{installed} in the booth, ~~the~~ ^{the} antenna is brought outside and the free end of its cord is attached to the end of the twine wound on the nail. The twine is then unwound from the nail and released. The weight pulls the antenna upright and will hold it in a vertical position. Experiment has shown that the antenna can also be placed horizontally on pegs driven into the ground in a direction opposite to the counterpoise. This removes the need for a ~~column~~ ^{post}. Three wooden pegs about 1 meter high and 2 meters apart are driven into the ground to suspend the counterpoise at an ~~angle~~ ^{angle} of 90° ~~with~~ ^{to} the antenna. The pegs have grooves ~~at the top~~ ^{at the top} in their upper part to support the counterpoise.

Another ~~column~~ ^{post} supporting the box for the telephone equipment is located 3 to 4 meters from the booth. A signal light, connected in series with the bell for transmitting the signals "Close the Circuit", "Launch", and others, is also mounted on this column. This signaling method is convenient and reliable, since if the bell is not heard, the light can be seen, and vice-versa. The telephone is necessary for conversations with the man receiving the signals, for transmitting check figures, etc.

CONFIDENTIAL
CONFIDENTIAL

83.
CONFIDENTIAL
CONFIDENTIAL

There is ^{also} a socket in the ^{post} ~~cabinet~~ for connecting lighting to the square ^(to the) and booth for taking ground checks during the dark part of the year.

The place where rasondes are launched must also be located so that the man receiving the signals can see what is happening in the square through the window of the aerological laboratory so that he can release his stop-watch when the rasonde is launched.

-END-

CONFIDENTIAL
CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

Chapter III. Preparation For Launching, Launching, and Reception of ^{Radioonde} ~~Radio~~

Signals

1. ^{ed} ~~Preparing~~ the ^{radioonde} ~~radio~~ for ^{launching} ~~launching~~ ^{by} ~~connecting~~ of the following steps:

1. External inspection of the instrument.
2. Ground check of the instrument in ^{shelter} ~~the room~~.
3. Checking the radio transmitter, tuning it for maximum ^{delivery} ~~signal~~ into the antenna in the wave band with the least noise.
4. Control check of the ^{radioonde} ~~radio~~.
5. Technical inspection of the instrument to find and remove defects in ^{the various} ~~its separate~~ parts.
6. Cleaning the contact arms, combs, and other contacting parts.
7. Regulating the contact strips of the commutator with the sprocket ^{wheels} ~~and~~ and the sliding contact on the humidity commutator.
8. Checking the electrical ^{assembly} ~~assembly~~ of the instrument.
9. Regulating the contact arms to provide smooth slipping along the combs and good contacts.
10. Control check of the Bourdon tube in the Garf instrument.
11. Filling ^{the} ~~the~~ plate and filament batteries.
12. Installing the transmitter in the instrument, ^{assembling} ~~assembling~~ the radio unit.

13. Installing the batteries for the radio transmitter.

14. Final assembly of the ^{radioonde} ~~radio~~.

It has been found ^{convenient} ~~practicable~~ in practice to perform these operations in the following order.

1. Set up the ^{radioonde} ~~radio~~ for a ground check ^(exposure) ~~(exposure)~~ in ^{shelter} ~~the room~~.

Having opened a new box with new ^{radioonder} ~~radio~~, a cursory inspection should

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

be made ~~(the contact arms, check to see that the joints are not jammed, etc.)~~.
 The ~~resonance~~ ^{radiosondes} are then brought into the air and set alongside the Asmann psychrometer. After 15 or 20 minutes, the Asmann psychrometer is set up and after 5 minutes, a reading is taken on the wet and dry thermometers ^{psychrometric} (psychrometers) with an ^{accuracy} ~~accuracy~~ of 0.1°, and the position of the temperature, pressure, and humidity contact ~~arms~~ ^{spins} on their combs is observed (with an accuracy of 0.1 teeth). The instrument should be tapped lightly before the reading. The data of the ground check in air should be written on the back of the certificate and on the instrument box.

In preparation for launching, one of the radiosondes ~~from which~~ ^{in air} a ground check ~~"ground"~~ has been taken is selected and set in the blower (see Chapter II, Section 1) and left for ~~20-25~~ ²⁰⁻²⁵ minutes for exposure. The transmitter can be prepared and tuned while the ~~radiosonde is standing in exposure.~~ ^{radiosonde being ground-checked}

2. Check the electrical circuit of the transmitter.
3. Check the ^{operation} ~~working condition~~ of the variable condenser.

After transportation and storage, the condenser plates (especially the movable plate ~~rotor~~ in the old models) are often bent and shorted. These should be checked and bent back ^{into} ~~into~~ the proper ^{shape} ~~shape~~. Sometimes the variable condenser is ^{shorted} ~~shorted~~ because the shaft of the rotor is not perpendicular to the stator. In this case, shorting usually cannot be ^{eliminated} ~~eliminated~~ throughout the band, ^{so} ~~and~~ the short must be eliminated at the position of the plates corresponding to the transmitter tuning. It is ^{better} ~~better~~ to use a new transmitter.

Sometimes, after shorting has been eliminated in ^{shelter} ~~the room~~, the condenser again shorts when the instrument is ^{brought} ~~carried~~ into ^{air} ~~the street~~. This is due to the different coefficients of expansion of the metal plates and the celluloid mounting. To avoid this, celluloid strips can be inserted ^{between} ~~between~~ the condenser plates.

CONFIDENTIAL

CONFIDENTIAL

- 26 -

CONFIDENTIAL
-86-
CONFIDENTIAL

The shorting of plates which occurred in 1941 model condensers was usually due to the screw holder ^{ins)} the movable plate. Sometimes the hole in the paraffinned pasteboard became ^{reamed out} widened and reached the fixed plate. When this happened, the screw could touch it, thus shorting the plates.

4. Check to see that the screw of the condenser is not touching the choke coil.

If the screw holding the movable plate of the condenser rubs against the choke, the insulation on the latter ^{will} be ruined, and the choke coil ^{will} be shorted to the movable plate. This, as seen in Figure 10, short circuits the plate battery. To avoid ^{this} ~~this~~, a drop of sealing wax, pitch, or Mendelejev putty should be poured on the end of the screw.

5. Clean the contacting parts of the transmitter (pins of oscillator, jacks, free ends of conductors, etc).

6. Check the operation of the oscillator tube.

This is usually checked by ^{putting} ~~inserting~~ the tube ^{intended} ~~designed~~ for the transmitter into the KUB-4 receiver.

7. ^{Install} ~~Insert~~ the tube into the transmitter.

8. Tighten up screws holding transmitter parts.

9. Prepare and check the antenna and ~~the~~ counterpoise.

10. Connect the transmitter to the indicator and tune it.

11. Solder the taps to the loops.

12. Take a ground check in ^{shelter} ~~the room~~.

The temperature should be read ^{from} ~~according to~~ the dry and wet thermometers of the Assmann psychrometer (with an accuracy of 0.1°) and then, having tapped the rasonde, the position of the temperature, pressure, and humidity contact arms on their combs should be noted (with an accuracy of 0.1 tooth). All this data ^{is} ~~was~~ recorded in the proper columns of the control check log-book. The data of the ground check "in air" which had been ^{recorded} ~~noted~~ previously

CONFIDENTIAL

CONFIDENTIAL

- 81 -

CONFIDENTIAL

CONFIDENTIAL

on the instrument box, ^{is} also recorded here.

13. Make a control check of the instrument.

The calibration of the instrument ^{may} ~~might~~ have changed considerably in the ^{which would lead} ~~process~~ transportation and storage, leading to poor sounding results.

A control check is therefore made to ^{ensure} ~~ensure~~ that the deviations between the indications of the instrument and the data taken from the calibration curves does not exceed the tolerances. In the control check, one should:

1. Compare the number of the certificate with the number of the instrument.

2. Check the correctness of the coefficient of temperature sensitivity.

3. Check the position of the temperature contact arm on the comb (for the observed temperature and the coefficient of sensitivity given in the certificate) to see that ^{temperature} ~~temperature~~ of -60-70° can be reached (before the contact arm is arrested by the lower stop).

4. Check to see that the difference of temperature amplitudes according to the instrument and according to the Assmann psychrometer does not exceed the established tolerances.

5. Check to see that the position of the pressure contact arm on the comb corresponds with the position which it should occupy (for the given pressure) according to the certificate. If this difference is greater than 15 millimeters, the instrument must be set aside ^{for} ~~until~~ a new check. ^{Changing} ~~Changing~~ the deviation by readjustment of the contact arm is not permitted.

6. Check to see that there is no difference between the position of the pressure contact arm for exposure in ^{shelter} ~~the room~~ and in air.

7. Make a control check of the Bourdon tube by rocking it in the Garf instrument.

8. Check the operation of the humidity element.

These operations in the control check are ^{accomplished} ~~executed~~ in the following way:

CONFIDENTIAL

CONFIDENTIAL

- 88 -

CONFIDENTIAL

CONFIDENTIAL

Checking the Correctness of the Calculation of the Coefficient of Temperature Sensitivity. For this purpose, the points of inflection of the curve on the ~~test graph~~ ^{calibration chart} for the temperature elements is found, i.e., the points bordering on sections with different sensitivity coefficients. If the inflection points were not ~~detected~~ ^{recorded by} in the ~~testing~~ ^{calibration} bureau, they can be determined by placing a ruler on the ~~test~~ ^{calibration} curve. Next, the number of teeth on the comb included between these points along the horizontal axis and the temperature change between them along the vertical axis is recorded (with an accuracy of 0.1°). ~~Division of the~~ ^{divided} ~~change of temperature~~ ^{obtained} by the number of teeth gives the sensitivity coefficient for this section of the curve. The sensitivity coefficients for the remaining parts of the curve are calculated in the same way. These are compared with the coefficients noted ~~on the~~ ^{chart} ~~graph~~.

If the deviation of the coefficient obtained in checking and that noted on the certificate exceeds 0.01°, the coefficients must be corrected by the senior aerologist after another check.

Calculation of the Extremal Temperature. Suppose, for example, that the temperature contact arm is on 6/4 (0.0), i.e., in the sixth section at the beginning of the 4th tooth. The air temperature is 22°; the sensitivity coefficient for the entire comb is 1.67. There remain 51 teeth to the end of the comb, in the traverse of which, the temperature will change 51×1.67 or -85.2°. Thus, the temperature which can be reached by the instrument when the contact arm is on the 2nd tooth of the 19th section is equal to -85.2° - (22°) = -107.2°, i.e., ^{corresponds} ~~corresponds~~ to the extremal temperature referred to ^{above} ~~above~~. If the extremal temperature had been equal to -50.0°, for example, instead of -107.2°, ~~then~~ the temperature contact arm would have had to be moved 8 or 9 teeth higher.

The extremal temperature at each individual station should be considered to be the minimum temperature ^{at} ~~of~~ the beginning of the stratosphere for that time of year. When the ^{radiosonde} ~~radiosonde~~ reaches the stratosphere, the temperature in

CONFIDENTIAL

CONFIDENTIAL

- 29 -

CONFIDENTIAL

CONFIDENTIAL

most cases will increase (or at ^{least} ~~least~~ the decrease will ^{gradient} ~~slow down~~ ^(be smaller) with height and the contact arm will start to return. The position of the contact arm can be changed ^{when the ϵ is} ~~for the case of~~ rectilinear ^(constant) ~~(sensitiveness)~~ sensitivity simply by moving the dowel pin 59 ^{along the} ~~rod~~ 44 (Fig. 1). Bending the bar 11 of the element is not permissible. ~~Moving of~~ the contact arm ^(should) ~~is~~ in general not ^{be moved when the ϵ is} ~~recommended in the case of~~ curvilinear sensitivity. Instruments which do not satisfy the requirements should be rechecked or left to be used at another time of the year when the temperature ^{is} of the beginning of the stratosphere is higher.

Checking the Sensitivity of the Temperature Element. The sensitivity of the temperature element is ^{checked from} ~~check according to~~ the data of the ground check of the instrument in air and in the ^{shelter} ~~room~~, recorded previously in the control check logbook. (Table 9)

Table 9 - Control Check Logbook of the Temperature Element of ^{Radiosondes} ~~Rasendes~~ (Dukhta Tiksi Polar Station)

Date of Ground Check	Instru-ment No.	Ground Check in the room ^{shelter}	Ground Check in Air	Position of Contact Arm	Psychro-meter	Position of Contact Arm
In Room ^{shelter}	In Air	Psychrom-eter of Contact Arm	Psychro-meter	Position of Contact Arm	Position of Contact Arm	Position of Contact Arm
25 March 1944	10 March 1944	4399	20.4°	6/3 (09)	-20.4°	13/1 (0.0)

Amplitude Ac-cording to Instrument	Amplitude Ac-cording to Psychrometer	Differ-ence	dt	Tolerance for Ampli-tude	Total Tolerance	Conclus-ion on Fitness	Signature of Checker
40.4	40.8	0.4	1.61	0.4	1.2	FT	Gudovana

First, the number of teeth passed by the contact arm from its position in the ground check in ^{shelter} ~~the room~~ and the ground check in ^{air} ~~the room~~ is calculated from the data obtained. In this case, the contact arm has passed 25.1 teeth. Multiplying the number of teeth by the sensitivity coefficient (dt equals 1.61° per tooth), we obtain $25.1 \times 1.61 = 40.4^\circ$, i.e., we obtain the number

CONFIDENTIAL

CONFIDENTIAL

-90-

CONFIDENTIAL

-90-

CONFIDENTIAL

of degrees ~~by~~ which the temperature must change ^(in air) to make the contact arm pass 25.1 teeth. This is the "amplitude according to the instrument". The amplitude according to the psychrometer in this case was $-20.4^{\circ} - (-20.4^{\circ}) = 40.8^{\circ}$. The difference between these amplitudes is 0.4° .

The difference of amplitudes must not exceed half the sensitivity coefficient of the temperature element. Inaccuracy of calibration may affect the difference of amplitudes in the case of large temperature amplitudes. ^{To provide for} this case, the tolerance, equal to ^{half} the sensitivity, can be increased by the following amounts:

Temperature Amplitudes	Addition to Half the Sensitivity	Temperature Amplitudes	Addition to Half the Sensitivity
30°	0.2°	45	0.5°
35°	0.3	50	0.6
40°	0.4		

If the difference in ^{amplitudes} exceeds the tolerances, the instrument is not fit for launching and must undergo a new check ^(6-B bibliography) with the participation of the senior aerologist. In our example, the sensitivity coefficient is equal to 1.61° , and the tolerance for amplitude 0.4° . Consequently, the total tolerance is equal to 1.2° ($0.8^{\circ} + 0.4^{\circ} = 1.2^{\circ}$). The difference of amplitudes is equal to 0.4° , and thus the instrument is fit for launching; this is noted in the proper column of the table.

For curvilinear sensitivity, the amplitude according to the instrument should be calculated in the following way. On the ^{calibration} ~~checking~~ curve of the temperature element, find the point corresponding to the position of the contact arm for ^{shelter} "ground check in the room" and calculate the temperature corresponding to this point according to the ^{chart} graph. Then find the point corresponding to the position of the contact arm for "ground check in air" and calculate the temperature. The difference of these temperatures gives the "amplitude according to the instrument" sought.

CONFIDENTIAL

CONFIDENTIAL

- 91 -
CONFIDENTIAL

CONFIDENTIAL

Fig. 88. Calibration Chart For the Pressure Element

CONFIDENTIAL

CONFIDENTIAL

- 72 -

CONFIDENTIAL

CONFIDENTIAL

Checking the Displacement of the Pressure Contact Arm. After reading the atmospheric pressure according to the barometer, make the necessary corrections (for temperature, for gravitational force, and for the instrument). Next, according to the pressure obtained, the ordinate is taken from the positive curve on the ^{calibration chart} checking-graph of the pressure element (Fig. 88) and a correction for temperature is made on it.

The ordinate obtained in this way should correspond to the ordinate of the position of the contact arm on the pressure comb. The ordinate corresponding to this position of the contact arm on the pressure comb is found by Tables 17 and 18 of reference (3) in the bibliography. The difference between these two ordinates (according to the ^{calibration} check and according to the instrument) must not exceed 15 millimeters. If this tolerance is exceeded, the instrument must be set aside for a new check.

Control Check of the Bourdon Tube. For a control check of the pressure element, the propeller shaft is removed, the ^{radial} ~~radial~~ is inserted in the Garf instrument (Figs. 38, 40), the position of the pressure contact arm on the comb at atmospheric pressure and the atmospheric pressure (according to the barometer, with a correction for temperature) is recorded, and the lower chamber of the Garf instrument is evacuated with a pump. After the by-pass valve is opened, the ^{contact} ~~pressure~~ arm is brought to the beginning or end of the teeth on the comb and readings are taken on the right and left legs of the manometer. The teeth must be selected so that the central points are positioned more or less uniformly throughout the ^{calibration chart} checking-graph. The following points are usually taken: position of the contact arm at ^{atmospheric} ~~atmospheric~~ pressure, 3s(0.9), 6s(0.0), 9s(0.0), and the position of the contact arm corresponding to the end of the ^{manometer} ~~manometer~~ range.

The following arrangement (Table 10) can be used for calculation and recording of the control check data.

CONFIDENTIAL

CONFIDENTIAL

-93-

CONFIDENTIAL

-93-

CONFIDENTIAL

Table 10 - Logbook of Control Check of Pressure Element

Date	Instru- ment No	Position of Contact Arm on Comb	Manometer			Temperature Corrected Correction	Corrected Manometer Indication	Pressure millimeters
			Right Leg	Left Leg	Total			

The position of the pressure contact arm 2c (0.8) at atmospheric pressure of 758.7 millimeters, corrected as indicated above, is written ^{on} in the first line. The manometer and air temperature readings are written ^{on} in the second line. Next, the total ^{readings} ~~indication~~ of the manometers must be reduced for a 0° temperature (to compare it with the initial atmospheric pressure). Table 11 is used in finding the correction; this table gives corrections, in 10° steps, ^{depending} ~~in dependence~~ upon the sum of the ^{readings} ~~indications~~ of the right and left legs of the manometer. The correction found is multiplied by the ~~observed~~ ^{corrected} temperature in degrees divided by ten. The correction obtained (-0.1) is subtracted from the sum of the ^{manometer readings} ~~manometer indications~~, and the corrected figure is subtracted from the atmospheric pressure (758.7), which gives the pressure corresponding to a position 3s(0.0) of the pressure contact arm and is equal to 729.8 millimeters.

Next, the chamber is evacuated until the contact arm moves to 6s(0.0), and the same calculations are made. A pressure of 509.8 is found, which corresponds to the beginning of tooth 6s, etc. Having completed the ^{check} ~~priming~~, control points are drawn on the ^{calibration chart} ~~checking graph~~ of the instrument and encircled according ~~to~~ to the pressure and position of the contact arm.

If the sensitivity of the Bourden tube has not changed and the check was made carefully, the control points will lie on the positive checking curve or be equidistant from it (displacement of the contact arm must not

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

Table 11- Temperature Corrections for Manometer Indications

Mercury Siphon Manometer At Normal Atmospheric Pressure

<i>Readings</i> Sum of Indica- tions of Right and Left Legs (in millimeters of mercury col- umn at 0°)	Temperature Corrections For Every 10°	<i>Readings</i> Sum of Indica- tions of Right and Left Legs (in millimeters of mercury col- umn at 0°)	Temperature Corrections for Every 10°	<i>Readings</i> Sum of Indica- tions of Right and Left Legs (in millimeters of mercury col- umn at 0°)	<i>Temperature Corrections for Every 10°</i>
--	---	--	---	--	--

CONFIDENTIAL

CONFIDENTIAL

- 75 -

CONFIDENTIAL

CONFIDENTIAL

exceed 15 millimeters). If the sensitivity of the pressure tube has changed, the control points will not lie on one curve. If the ^{projection of} difference between the greatest and least distances of the points from the curve (the positive curve or one parallel to it) exceeds ^{one} 2 millimeter ^{section} along the horizontal, the instrument is unfit for launching and must be calibrated ^{again} anew.

If the conditions and equipment of the station permit a complete check according to the ^{"Nostrovleniye"} ~~rules of instruction~~ (6-bibliography), the instrument can be calibrated ^{calibration chart} anew and a new ~~checking graph~~ constructed. With the permission of the Arctic Institute, the instrument can then be used, ~~proceeding from the data of the new check.~~

Checking the Operation of the Humidity Element. For this purpose, the relative humidity is ^{calculated} ~~calculated~~ according to psychrometric tables from readings of the dry and ^{wet} ~~wet~~ thermometers ^{for ground-check shelter} ~~when composed in the room~~ and in air.

Next, the humidity value corresponding to the position of the humidity contact arm on the comb recorded for ^{ground-check shelter} ~~exposure~~ in air and in the ^{shelter} ~~room~~ is taken from the ^{calibration chart} ~~checking graph~~ of the humidity element (Fig. 87). ^{are compared} ~~Comparison of~~ these values and ~~decision as to~~ the quality of operation of the humidity element is ^{determined} ~~made as stated on page 100~~. If the control check shows that the instrument satisfies all tolerances, ~~then work can be continued in preparing the instrument, which first involves more mechanical cleaning.~~

14. Check to see that the parts of the instrument are ⁵¹¹ ~~installed firmly~~ ^{tight}.

15. Check to see that the propeller shaft rotates easily.

16. Check to see that there is no binding in the ^{linkages} ~~hinged connections~~ of the elements with the contact arms.

17. Check to see that the pivot axes of the contact arms are perpendicular to the plane of the channel frame.

CONFIDENTIAL

CONFIDENTIAL

- 75 -
CONFIDENTIAL

- 76 -
CONFIDENTIAL

18. Check to see that there are detents on the combs.

19. Check to see that the sprocket ^{wheels} are in the correct position.

The last teeth of all sprocket wheels (considering counter-clockwise ^{for} ~~rotation~~ ^{CONNECTIONS} ~~movement of the commutator~~) and the generating line of the pressure sector should all be located on one vertical line.

20. Clean the ^{temperature} contact arm and comb.

21. Clean the commutator ^{sprocket} wheels and contact strips.

22. Regulate the pressure of the contact strips on the sprocket wheels.

23. Clean the humidity commutator bars and regulate the sliding contact.

24. Clean the pressure contact arm and comb.

25. Clean the humidity contact arm and comb.

26. Check the ~~correctness of the~~ electrical wiring of the instrument.

27. Regulate the contact arms (which were lifted behind the detents ⁱⁿ ~~during the electrical check~~).

28. Prepare a filament battery as shown ^{on pp. 39-40} ~~except~~ 39-38 if none is available.

29. Prepare the battery for filling.

30. Wet the ^{anode} plate of the batteries with electrolyte (saturated solution of sal ammoniac in distilled water) and pack it.

31. Fill the batteries with the electrolyte up to the edges of the containers and leave to soak in.

32. Install the transmitter in the instrument.

33. Prepare and connect the propeller and extension rod to the instrument.

34. Prepare the batteries to place them in the instrument.

35. Insert the batteries in the instrument and connect them as shown in

Figure.13.

CONFIDENTIAL

CONFIDENTIAL

- 91 -
CONFIDENTIAL

- 17 -
CONFIDENTIAL

36. Tune the transmitter in the instrument.
 37. Make a general inspection of the instrument.
 38. Prepare the ^{postboard} ~~postboard~~ box and put it on the instrument, and
 39. Put the additional shield (if this is necessary) on the instrument.
 40. Before the final assembly of the instrument, set up the instrument for exposure ^{ground check in shelter} ~~"in-the-room"~~. For this purpose, set the instrument on the ventilation unit, start it, and suspend an Assmann psychrometer at the level of the ^{radio sound} ~~radio~~ elements. The canbric of the ^(psychrometer) ~~psychrometer~~ is moistened with water. Five or six minutes before the ^{ground check} ~~exposure~~ is begun, the suction apparatus of the psychrometer is started. The ^{ground check} ~~exposure~~ is taken in the following ^{steps} order:
 - a. Read the indications of the dry and wet thermometers of the Assmann psychrometer with ^{an accuracy of} ~~an accuracy~~ of 0.1° and record the data on a piece of paper.
 - b. After tapping the instrument, record the position of the contact temperature arm on the comb. First observe the tenths of a tooth (with an accuracy of 0.1 tooth) and ^{then} ~~then~~ the number of the tooth and section.
 - c. Record the position of the pressure contact arm (same accuracy).
 - d. Record the position of the humidity contact arm (same accuracy).
 - e. Record the atmospheric pressure according to the barometer with an accuracy of 0.1 millimeter and make all corrections. The pressure is not reduced to ^{sea} ~~sea~~ level. If the height of the barometer differs by more than 5 meters from the height of the launching point, the barometer indication must be reduced to the height of the launching point, ^{allowing} ~~allowing~~ 0.1 millimeter per kilometer.
- After ^{ground check in shelter} ~~exposure in-the-room~~, the instrument is taken out to the launching point. The aerologist ~~remaining~~ at the receiver records the ^{ground check} ~~exposure~~ in ^{shelter} ~~room~~ data in the proper columns on the front of the radio reception ^{blank} ~~blank~~ (see the example in Table 12).

CONFIDENTIAL

CONFIDENTIAL

- 78 -

CONFIDENTIAL

CONFIDENTIAL

an "Initial t° dry... wet....", the temperature taken
 an psychrometer is ~~written~~ ^{recorded 2/012} together with the instrument cor-
 or these indications.

position of the temperature contact arm is written in the column
 act $t^{\circ} \frac{B}{N}$. It is written in the form of a fraction, the numerator be-
 the section number and the ~~denominator~~ ^{denominator} the tooth number; the tenths of
 a tooth are written in parentheses alongside this fraction. In the example
 given, the temperature contact arm is in the seventh section on a control
 tooth 0.7 from its beginning, which is written 7/k (0.7).

The relative humidity according to psychrometric tables ^{readings} from the ~~initial~~
 ations of the dry and wet thermometers and the separately added correction
 to it for the pressure difference according to Tables 1a and 1b of the "Psy-
 chrometric Tables" is written in the column "Initial F %". In our example,
 the relative humidity is equal to $35 + 4 = 39\%$.

The numbers of the tooth of the humidity comb (and tenths in parentheses)
 on which the humidity contact arm is resting is written in the column "Con-
 tact F (tooth)". In the example, it is resting on the 7th tooth 0.6 from its
 beginning, which is written 7z (0.6).

The corrected pressure is written in the column "Initial B_m ".

The number of the tooth of the pressure comb (silver or celluloid), and
 the tenths in parentheses, upon which the pressure contact arm is resting
 is written in the column "Contact B_m (silver, celluloid)". In the example,
 the pressure contact arm is resting on the 3rd silver tooth, 0.1 from its
 beginning, which is written 3s (0.1).

41. Set up the instrument at the launching point and check the operation
 of the receiver.

CONFIDENTIAL

CONFIDENTIAL

- 75 -

CONFIDENTIAL

CONFIDENTIAL

In the column "Initial t° dry... wet....", the temperature taken from the Assmann psychrometer is ^{recorded along} written together with the instrument corrections for these indications.

The position of the temperature contact arm is written in the column "Contact $t^{\circ} \frac{s}{n}$ ". It is written in the form of a fraction, the numerator being the section number and the ^{denominator} the tooth number; the tenths of a tooth are written in parentheses alongside this fraction. In the example given, the temperature contact arm is in the seventh section on a control tooth 0.7 from its beginning, which is written 7/k (0.7).

The relative humidity according to psychrometric tables ^{corrected} from the ~~indicated~~ readings of the dry and wet thermometers and the ~~separately added~~ ^{added} correction to it for the pressure difference according to Tables 1a and 1b of the "Psychrometric Tables" is written in the column "Initial F %". In our example, the relative humidity is equal to $35 + 4 = 39\%$.

The number of the tooth of the humidity comb (and tenths in parentheses) on which the humidity contact arm is resting is written in the column "Contact F (tooth)". In the example, it is resting on the 7th tooth 0.6 from its beginning, which is written 7z (0.6).

The corrected pressure is written in the column "Initial B_m ".

The number of the tooth of the pressure comb (silver or celluloid), and the tenths in parentheses, upon which the pressure contact arm is resting is written in the column "Contact B_m (silver, celluloid)". In the example, the pressure contact arm is resting on the 3rd silver tooth, 0.1 from its beginning, which is written 3s (0.1).

41. Set up the instrument at the launching point and check the operation of the receiver.

CONFIDENTIAL

CONFIDENTIAL

- 79 -

CONFIDENTIAL

- 17 -

CONFIDENTIAL

42. Set up the instrument for ^{ground check in air.} exposure ~~"in shelter"~~.

This requires the following ^{steps}.

1. Start the ventilation unit; after 5 or 10 minutes, start the suction apparatus of the Asmann psychrometer; after 5 more minutes, take the ^{ground check} ~~expos-~~ure, i.e., ^{take readings} ~~read~~ the indications of the dry and wet thermometers and the position of the contact arms on the combs.

2. Leaving the instrument on ^{ground check} exposure, report the data of the ^(ground check) exposure to the aerologist at the receiver. The latter compares this data with the ^{ground check} exposure "in shelter". The difference of amplitudes according to the instrument and according to the psychrometer is calculated and compared with tolerances; moreover, the readings of the position of the pressure contact arm ^{ground check} for exposures "in shelter" and "in air" are compared. These positions should coincide, ^{ing} ~~without allowance~~ for the influence of temperature upon the operation of the Bourdon tube. Maximum permissible deviation is 0.1 tooth.

If the deviation ^{tion} exceeds this tolerance, the calibration chart must be ^{inspected} ~~submitted~~ to see how the ordinate changes for a ^{drop} ~~reduction~~ in ^{drip} ~~temperature~~. If, for example, the ordinate increases for a ^{ground checks} ~~decrease~~ in ^{ground checks} ~~temperature~~, and an increase of the ordinate is also observed in comparing exposures, then it may be ~~considered~~ that the displacement of the pressure contact arm is legitimate. If the direction of change of the ordinate is different according to the calibration ^{chart} ~~curve~~ and according to the ^{ground check} exposure, the instrument must be ^{ground-checked} ~~again exposed~~, and if the nonconformity is ^{observed} ~~observed~~ in the repeated exposure, the instrument must be set ^{aside} ~~aside~~ for a new check. In the example (Table 12), the position of the pressure contact arm for exposure "in shelter" is 3s (0.1) and in air is 3s (0.2), and the displacement is within the tolerance limits.

Next, the quality of the ^(ground-check) exposure of the humidity element is established. This requires comparison of the ~~deviation between~~ the humidity determined

CONFIDENTIAL

CONFIDENTIAL

- 100 -

CONFIDENTIAL

- 100 -

CONFIDENTIAL

from the psychrometric tables or from a hygrometer (when the temperature falls below -15°) ^{must be compared with} and the humidity taken from the calibration chart according to the position of the contact arm on the humidity comb for exposure "in shelter" and "in air". Thus, in our example, the ^{ground check} humidity "in shelter" calculated from the table is 39% and from the calibration chart, 46%; the difference is 7%. "In air", these values are respectively 83% and 70%, i.e., a difference of 13%. Comparing the deviations for both exposures, we have $-7 - (-13) = 20\%$. The normal difference observed is not greater than 8%.

As experience shows, however, this difference is frequently much greater and is especially great under negative temperatures, when the inertia of the element increases greatly (as is apparently the case in our example). The deviation ^{may} also be considerable ^{at comparatively} high temperatures ^{because of} contamination of the hair. Because of these unavoidable defects of the humidity element (strands of hair), the instrument is not rejected even when the deviation ^{is} ^{greater than} considerably ~~exceeds~~ the tolerance.

The data of the ^{ground check} exposure "in air" and the results of their comparison, if they satisfy the tolerances, are written in the proper columns on the front of the reception blank in the same way as the data of the ^{ground check} exposure "in shelter".

The data on the comparison of temperature amplitudes is written in an empty space on the sheet above the heading "In Air" (Table 12). The difference between t° according to the instrument, i.e., the temperature amplitude calculated from the sensitivity of the instrument and the number of teeth passed by the contact arm, and the temperature from the dry thermometer from the chart "In Shelter" is written here. This difference must not differ from the temperature according to the ^{plus} dry thermometer from the chart "In air" by more than half the sensitivity ^{with the addition of the} tolerance for the ^{12.86} magnitude of the ^{amplitude}. In our example, this dif-

CONFIDENTIAL

CONFIDENTIAL

- 101 -

CONFIDENTIAL

- 101 -

CONFIDENTIAL

ference is equal to $-32.8 - (-32.3) = 0.5$, which ^{easily} satisfies ^{the} tolerances.

43. Prepare the balloon.

While the instrument is standing on ^{ground check} exposure and the ^{ground check} data of the ^{By the time} exposures is being compared, the aerologist in the square prepares the balloon. ^{When} the instrument was taken out in air, the balloon had already been filled with hydrogen to the required lift and ^{is} located in the aerological pavilion.

Aerologists inspect the balloon ^{and} measure and record in a notebook its perimeter and lift. If the balloon is to be launched in a high wind, the netting is added to the balloon here.

After receiving a report from the aerologist at the receiver on satisfactory results of comparing the ^{ground check} data of exposures, the balloon is taken out of the pavilion to the launching point in the square.

44. Taking out the balloon and attaching the ^{radiosonde} ~~sonde~~ to it. In high winds, it is most efficient to ^{attach} the instrument in the aerological pavilion where the balloon is located. In good weather, the balloon is carried out and the instrument ^{is} attached in the square. Then ^{release} the cord (with the antenna ^{is}) from the block and ^{tie} its free end securely to the appendix, ^{gradually} letting the balloon ascend, ^{holding it back} with the cord at the instrument.

The following operations are:

1. Start the Asman psychrometer.
2. Tie a lantern to the end of the counterpoise (if the ^{radiosonde} ~~sonde~~ is to be launched in the dark part of the year and if pibal observations are to be made).
3. One aerologist holds the balloon and a second sends the signal "Closing the Circuit" to the aerologist at the receiver. After hearing the answer "Heard", the ^{the} wires ^{and} housing are securely connected and the propeller is rotated.

CONFIDENTIAL

CONFIDENTIAL

-102-
CONFIDENTIAL

-102-
CONFIDENTIAL

4. After having tuned to the ^{radiosonde signal} ~~resende signal~~ and made sure that the transmitter is operating correctly, the aerologist at the receiver transmits the signal "launch".

5. Having received the ^{launching} ~~launching~~ order, a ^{suitable} ~~suitable~~ moment is selected and the balloon is launched. The time of launching is recorded by the aerologist on a stop-watch, which is later given to the person receiving the signals to check with his stop-watch. If the person receiving the signals can observe the launching, he closes his stop-watch precisely at the time of launching. If he misses this launching time, the time readings are ^{adjusted} ~~adjusted~~ by a correction constant equal to the difference ^{square} ~~square~~ in the time from both stop-watches, and for further reception, the stop-watch taken from the square is used.

6. Directly after launching, the temperature is read according to the dry thermometer ("temperature before launching"), and the cloudiness, atmospheric phenomena, and wind ^{are} ~~and~~ determined and recorded, if pibal observations are not made on the balloon; if they are made, this data is taken from the pibal book, p. 1, and ^{rewritten} ~~rewritten~~ in the reception records of the ^{radiosonde} ~~resende~~ signals.

45. Launching of ^{radiosondes} ~~resendes~~ in high winds.

In high winds, (15 meters per second and higher), ^{radiosondes} ~~resendes~~ launching of ~~resendes~~ is made very difficult because of the possible break of the appendix. The following launching method was devised and checked in Bukhta Tiksi in 1943 and 1944 (A. A. Girs and V. Ye. Blagodarov) to avoid this difficulty.

Envelope No 50, filled with hydrogen, ^{with} ~~and~~ 2/3 of its surface covered with a ^{seine} ~~cording~~ ~~net~~ ~~is~~ ~~employed~~, is employed. The netting weighs about 150 to 200 grams. Eight of ten strands dangle from the netting, which are gathered underneath the balloon and tied in a knot. The ends must be

CONFIDENTIAL

CONFIDENTIAL

- 103 -

CONFIDENTIAL

- 103 -

CONFIDENTIAL

Tied
~~about~~ far enough away from the balloon so that they will not interfere with its expansion during ascent; this knot is usually made, therefore, 2.5 to 3 meters from the lower surface of the balloon. ~~There is about an 8 square meter~~ ^{The balloon envelope} surface of the balloon (envelope No 50) for a perimeter of about 500 centimeters; therefore, a net with an area of about 5 square meters, i.e., 222 ^{centimeters} meters in width and the same in length, is necessary to cover 2/3 of the balloon. The appendix is attached in the center of the netting, after which the balloon turns around with its appendix upward. The instrument is attached to the ends of the cords. The ^{radio} ~~rasonde~~ antenna together with the cord is wound around one of the cords and attached to the netting. The counterpoise is also lifted up (Figure 77) and tied to the netting on the

Fig. 77. Diagram of the Arrangement of the Netting, Instrument, Antenna and Counterpoise for Launching a Rasonde on a Day With High Winds (N. F. Zhirkov's Photo)

other side of the balloon. When the antenna and counterpoise are positioned at an angle, the amount of power delivered to the antenna is affected adversely. As experience shows, however, this does not affect the audibility of signals in practice. (See given good supply and tuning of the transmitter).

The balloon is launched in the following way. Grab the ends of the netting at the instrument with the right hand and slightly higher (1 meter) with the left. ^{When the wind is blowing in gusts} ~~For an interruption~~, await a moment of relative calm when the

CONFIDENTIAL

CONFIDENTIAL

-104-
CONFIDENTIAL

-104-
CONFIDENTIAL

balloon is not touching the ground and makes an ^{angle} ~~angle~~ of 45° with the horizontal, and then release the left hand and run ^{downwind} ~~downwind~~ with the balloon. When the balloon is close to the vertical, launch it by releasing the ends from the right hand.

The vertical speed of ascent of the sonde with a netting is less than that for the same sonde without a netting. This is due to the resistance which the netting loaded by the instrument offers to expansion of the balloon. The ^{velocity gradient} ~~decrease in speed~~, which is considerable ^{at} in the lower levels, ^{decreases} ~~diminishes~~ with height. The decrease in vertical speed, however, has little influence upon the height of ascent. Heights of 16 kilometers and above with good audibility in the loudspeaker have been attained in Bukhta Tiksi using an envelope No 50 with netting. Thus, this method has justified itself in practice. It makes possible launching of ^(radiosonde) ~~sondes~~ without risk even in winds ^{above} ~~exceeding~~ 20 meters per second.

46. Reception and recording of ^(radiosonde) ~~sonde~~ signals.

In the reception and recording of ^(radiosonde) ~~sonde~~ signals, the following things ^{should} ~~must~~ be kept in mind:

1. A stop-watch with a face having 100 divisions is necessary to fix the time when signals begin. An ordinary stop-watch may be used for this purpose if a paper ring having 100 divisions is added to it. This ring is inserted beneath the glass over the stop-watch divisions. Time readings in hundredths of a minute are very convenient for setting down the data of the ascent on the graph.
2. The time when signals begin is recorded with an accuracy of 0.05 minutes; henceforth, hundredths of a minute will be called seconds.
3. In the first line of the reception blank (Table 12) is entered "0 minutes and 00 seconds"; and next in the column "S" ^(stand for "section") ~~(stand for "section")~~, the number of the section, and in the column "n", the number of the tooth, upon which the temperature contact arm is resting at the time of launching, i.e.,

CONFIDENTIAL

CONFIDENTIAL

- 105 -

CONFIDENTIAL

- 105 -

CONFIDENTIAL

the number corresponding to the number of dots heard (or dots with a dash if there is also a pressure signal, or a letter K if the contact arm is resting on a control tooth); ^{"x"} ~~an "x"~~ ^(~~take a multiplication sign~~) is made in the column "B" if a pressure signal is heard simultaneously with the temperature signals at the time of launching; the number of the tooth upon which the humidity contact arm is resting is entered in the column "F". In order to recognize this number, the propeller ^{or} must be rotated before launching until no humidity signal is heard.

4. During further reception, the times of change of the temperature signals are written down; moments of time between whole minutes in the "Minutes" column are left blank *if the temperature signals do not change.*

If the time when pressure signals begin does not coincide with the time when temperature signals change (which is usually the case), the temperature signal is written down again with the cross next to it (in the "B" column). The time when the pressure signals begin is noted in the "Time" column in this case. The same procedure holds ^{if} when the times ^{when} the pressure signals stop ~~do not~~ coincide with the times ^{when} the temperature signals change. The time when the pressure signals end is denoted by a dash in the "E" column.

5. The number of the humidity teeth is written in the column "F", and the time when the signal begins with an accuracy of 0.10 minute is ^{written} ~~written~~ above it in the same column. For speeds of ascent of the balloon of around 350 meters per minute, the humidity signals are transmitted every 35 to 40 seconds. If the humidity contact arm has not moved to a new teeth in this time, the number of the signal is again ^{written} ~~written~~ in the "F" column, but the time is not recorded.

^{velocity gradient} The change in the vertical speed of the balloon is usually checked by the times when the humidity call signals change. If the speed of ascent

CONFIDENTIAL

CONFIDENTIAL

- 105 -
CONFIDENTIAL

- 106 -
CONFIDENTIAL

increases (the temperature signals are repeated more frequently), the time required for a complete revolution of the sliding contact (between ~~the~~ ^{vice-versa} the ~~beginning of call signals~~) decreases and if ~~the speed of ascent decreases, the time required for a complete revolution of the sliding contact increases.~~ Therefore, if during signal reception the temperature signals become more frequent or more infrequent, the time of the beginning of the humidity call signals must be written down 2 or 3 times in a row. This time is read from the stop-watch with an accuracy of 0.01 minute and written in a empty space of the "F, %" column (opposite the figure in the "F" column). These readings must be made approximately every 5 minutes to check the vertical speed during the entire ascent.

The humidity call signals should be listened to very attentively when the pressure contact arm is approaching the 9th teeth. The time when three call signals are heard instead of two is noted in the "B" column by three crosses (xxx).

6. If there is a lapse in the temperature ^{signals} ~~signals~~ during reception, a line should be left between the last signal before the lapse and the following signal and underlined with a long mark (_____).

7. If the temperature contact arm ^{rests} ~~rests~~ on the ^{gap} ~~interval~~ between two neighboring teeth, first one, then another, signals will be heard for a short time. The time of change should be recorded only after the nature of the new signal is definitely determined.

8. During reception, the change of signals is compared with the diagram ^{the} ~~of~~ ^{comb teeth}. Special attention should be given to the position and sequence of control teeth. The numbers of the sections should be set down in order during reception (in the "S" column alongside the first teeth in each section. ^{helps one to follow} This ~~plan~~ ^{signals} ~~plan~~ ^{consciously} ~~plan~~ ^{plan} following the behavior of the signals easily and ~~consciously~~ ^{consciously} ly and not automatically.

CONFIDENTIAL

CONFIDENTIAL

- 107 -
CONFIDENTIAL

- 107 -
CONFIDENTIAL

9. If any signal is heard poorly and the person receiving the signals is ~~not sure~~ ^{in doubt} about it, a question mark should be placed near the number of the signal.

10. Signal reception is best conducted in pairs, i.e., ^{one} ~~two~~ man receives and records the temperature and pressure signals while the other records the humidity signals on a separate sheet of paper and also tunes the receiver.

11. Given sufficient training, some signal processing can be carried out during signal reception. For example, the numbers of the pressure teeth can be set down in order during reception of pressure signals. Knowledge of the number of the present and following pressure teeth permits more conscious and reliable recording of the time for the end of the given teeth. Thus, knowing that signals of the 6th teeth have been heard and that it is twice as wide as the 5th tooth, the time when ~~signals of the 6th teeth~~ ^{signals of the 6th teeth} will end can be approximately surmised and consequently, noted reliably. It often happens in practice that some pressure signals will last for a considerable time. Then suddenly, it will not be heard for one or two times because of technical reasons. The aerologist notes the end of the pressure ^{signals} ~~signals~~ and considers, when they are again heard, that the contact arm has passed to a new tooth, ~~when actually it has contact arm is on the same tooth.~~

Such cases are eliminated to a considerable degree when the behavior of the teeth is checked continuously, i.e., when the numbers are set down as they occur. The ^{teeth} ~~teeth~~ numbers are written above and to the right of the pressure crosses. At the same time, the duration of the ^{signals} ~~signals~~ from the teeth just passed is calculated and this figure is written somewhere in the "S" column opposite one of the crosses of the given pressure teeth.

The pressure signals are usually processed according to ^d ~~the~~ ³¹³ ~~the~~ moments of time when the contact arm is on the middle of a tooth (see page ~~213~~ ²¹³, text).

CONFIDENTIAL

CONFIDENTIAL

- 108 -
CONFIDENTIAL

- 108 -
CONFIDENTIAL

^{Times}
These ~~moments~~ are found in the following way: divide the duration of the signals from the given teeth in two (from the "S" column) and add half of this time to the time when the pressure signals began. The result obtained is written in the margins to the left of the "Time" column. If the beginning or ^{end} of the pressure signals is unreliable, the signals are ^{processed as} ~~processed according~~ to the times when the signals began or ended, depending upon which is ^{considered more} ~~considered~~ reliable. In this case, the time for the ^{middle} ~~middle~~ of the teeth is not calculated, and the mark "V" is placed opposite the beginning or end in the margins, which indicates whether the beginning or end of the given teeth should be used in processing. All these calculations are made when possible, of course, and should not be allowed to interfere with signal reception.

12. If the entire ^{blank} ~~blank~~ is used in recording signals, inserts should be taken and the recording continued on them.

13. If the balloon breaks or an air hole appears, the instrument will start to drop. The pressure signals will then be heard before the temperature signals. This should be watched carefully and the moment when the pressure signals heard first noted by the words "Pressure ahead". Otherwise, the change of signals in processing might be taken as a result of ascent of the rasonde, giving incorrect results and a false height of ascent.

14. After having made sure that the signals have disappeared (after searches and waits), the time ^{and} ~~and~~ reason for the end of signal reception should be written on the front of the reception blank. The latter is often noted thus: "Continuous chirp", "Signals weak", "Signals stopped abruptly", "Balloon burst", etc.

We now give some instructions ^{on} ~~in~~ tuning the receiver during reception:

15. As soon as the balloon starts to move away from the earth, the ^{transmitter} ~~transmitter~~ wave-length usually decreases and the knob of tuned circuit II ^{must} ~~must~~ be turned slightly to the left to retune the receiver. ~~Further tuning~~

CONFIDENTIAL

CONFIDENTIAL

- 109 -

CONFIDENTIAL

- 109 -

CONFIDENTIAL

should be done ^{for} ~~when the~~ humidity call signals, or triple, quadruple, and control temperature signals ~~are being passed~~. Tuning on single and double signals is not recommended because it is easy to lose the signals entirely in this case.

The temperature and pressure signals are often transmitted at different wavelengths. The pressure signals are usually transmitted at shorter wavelengths and may be found by turning the knob of control circuit II to the left. When this occurs, the receiver is first tuned to good audibility ~~of~~ ^{for} the temperature signals and then to good ^{audibility} ~~audibility~~ ^{for} the pressure signals. Simultaneous audibility of both signals will be found at a pointer position of the dial of tuned circuit II somewhere in the middle of these two extreme positions. Usually, one "feels" that the pressure signals are going to "enter" soon. In this case, the pressure signals are tuned in ~~to~~ ^{position} ~~order~~ to note its beginning accurately, and then the mid-~~position~~ ^{position} is again established by turning the knob. Just before the pressure signals end, this procedure is repeated to determine its end accurately.

During the first minutes of reception, it is better not to use the antenna, because sharp crackles, interfering with reception, are often observed when the antenna is connected. As soon as the instrument is removed from the earth's surface (approximately 5-8 minutes), the antenna is connected.

A loudspeaker is usually used for signal reception. ~~When~~ the signals become weak and ~~are poorly heard in the speaker~~, a headset is used. If two men are receiving signals, two pairs of headsets connected in parallel should be used. If the receiver breaks down during reception, it should be disconnected and the spare receiver connected without delay. After reception is completed, the receiver is disconnected and the reception blank filled out.

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- 110 -
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- 110 -
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16. The following are written at the top of the reception blank: ^{the place of} ~~the place~~ ^{radiosonde launching} where the radiosonde was launched, the number ~~of the~~ ^(radiosonde) instrument, the number ^{of} ~~the~~ ^{numerator} ~~the~~ (usually given in the form of a fraction, whose ~~denominator~~ shows the number ~~of the~~ ^(sonde) in the given month, and the denominator, the number ~~of the~~ ^(sonde) since the beginning of the year), and the date and time (mean solar) ~~of~~ ^(launching). After the ^{blank} ~~blank~~ is filled out (Table 12), the ^{radiosonde} ~~radiosonde~~ signals are processed, and a telegram is made up and sent to the Rayon Weather Bureau.

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Table 12

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Arctic Scientific-Research Institute
Main Administration of the Northern Sea Route

M-16
1936

Network of Hydrometeorological Stations
Place Where Rasonda Was Launched Polar Station of Bukhta Tiksi

Instrument No 4399

TABLE OF NOTES OF OBSERVATIONS AND PROCESSING OF RASONDA NO 7/121
" 26 " March 1944

Time of Launching 8 Hours 04 Minutes
Degrees on the Tuning Dial: At the Beginning 72, At the End 47
Antenna Length 3.5 meters
Counterpoise Length 3.5 meters
Plate Battery 48 Volts
Filament Battery 3.4 Volts
Weight of the Instrument With Batteries 970+240(netting) = 1210 grams

t° According to Instrument 49.2 - 51.5 = 232.3
Ground Check
Exposure

	In Shelter	In Air
Initial t° Dry	<u>19.2 - 0.0 = 19.2</u>	<u>32.8 - 0.1 = 32.7</u>
Contact t° Wet	<u>11.8 - 0.1 = 11.7</u>	<u>32.7</u>
Contact t° H	<u>7/k (Q7)</u>	<u>15/2 (0.3)</u>
Initial F%	<u>35 + 4 = 39</u>	<u>72 + 11 = 83</u>
Contact E_n (tooth) 7s(Q6)	<u>39 - 46 = -7</u>	<u>4s(Q8) 83 - 70 = -13</u>
Initial B_n (silver, celluloid) 2s(Q1)	<u>3s(Q1)</u>	<u>3s(Q2)</u>
Contact B_n (silver, celluloid) 3s(Q1)	<u>3s(Q1)</u>	<u>3s(Q2)</u>
t° Before Launching: Dry	<u>-32.2 + 0.1 = -32.1</u>	<u>Wet</u>
Audibility of Signals	<u>Good and Clear</u>	<u>-</u>
Reason For Reception Ending	<u>Fading of Reception</u>	<u>-</u>
Instrument Checked By	<u>V. Ye. Blagoderov</u>	<u>-</u>
Instrument Prepared By	<u>O. V. Gudovana</u>	<u>-</u>
Signals Received By	<u>O. V. Gudovana</u>	<u>-</u>
Quantity and No of Envelope(s)	<u>1 N50</u>	<u>2pir 500 A 21.00</u>
Cloudiness	<u>% Cl</u>	<u>Wind Calm</u>
Instrument Became Obscure	<u>-</u>	<u>Became Hidden - Helocids</u>
Notes	<u>-</u>	<u>-</u>

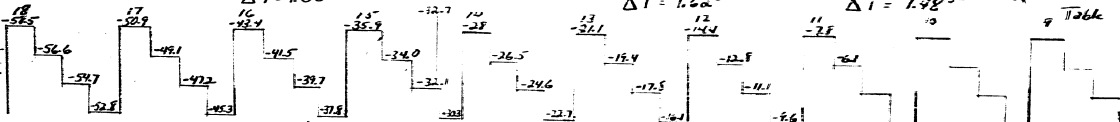
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$\Delta T = 1.88^\circ$ $\Delta T = 1.66^\circ$ $\Delta T = 1.62^\circ$ $\Delta T = 1.48^\circ$

Table 12 - Continued



Entries and Processing

Time		Contacts				Pressure				Height			
M.H.	Sec.	S	n	B	F	°	°	°	°	°	°	°	°
0	00	15	1	X	4	-32.0	83	35.1	27.3	-32.7	774	1032	-123
1	20	14	4	X		-30.3							
2	40	13	3	X		-28.4							
3	00	15	1	X	4	-26.5							
4	20	14	4	X		-24.6							
5	40	13	3	X		-22.7							
6	00	15	1	X	4	-20.8							
7	20	14	4	X		-18.9							
8	40	13	3	X		-17.0							
9	00	15	1	X	4	-15.1							
10	20	14	4	X		-13.2							
11	40	13	3	X		-11.3							
12	00	15	1	X	4	-9.4							
13	20	14	4	X		-7.5							
14	40	13	3	X		-5.6							
15	00	15	1	X	4	-3.7							
16	20	14	4	X		-1.8							
17	40	13	3	X		0.1							
18	00	15	1	X	4	2.0							
19	20	14	4	X		3.9							
20	40	13	3	X		5.8							
21	00	15	1	X	4	7.7							
22	20	14	4	X		9.6							
23	40	13	3	X		11.5							
24	00	15	1	X	4	13.4							
25	20	14	4	X		15.3							
26	40	13	3	X		17.2							
27	00	15	1	X	4	19.1							
28	20	14	4	X		21.0							
29	40	13	3	X		22.9							
30	00	15	1	X	4	24.8							
31	20	14	4	X		26.7							
32	40	13	3	X		28.6							
33	00	15	1	X	4	30.5							
34	20	14	4	X		32.4							
35	40	13	3	X		34.3							
36	00	15	1	X	4	36.2							
37	20	14	4	X		38.1							
38	40	13	3	X		40.0							
39	00	15	1	X	4	41.9							
40	20	14	4	X		43.8							
41	40	13	3	X		45.7							
42	00	15	1	X	4	47.6							
43	20	14	4	X		49.5							
44	40	13	3	X		51.4							
45	00	15	1	X	4	53.3							
46	20	14	4	X		55.2							
47	40	13	3	X		57.1							
48	00	15	1	X	4	59.0							
49	20	14	4	X		60.9							
50	40	13	3	X		62.8							
51	00	15	1	X	4	64.7							
52	20	14	4	X		66.6							
53	40	13	3	X		68.5							
54	00	15	1	X	4	70.4							
55	20	14	4	X		72.3							
56	40	13	3	X		74.2							
57	00	15	1	X	4	76.1							
58	20	14	4	X		78.0							
59	40	13	3	X		79.9							
60	00	15	1	X	4	81.8							
61	20	14	4	X		83.7							
62	40	13	3	X		85.6							
63	00	15	1	X	4	87.5							
64	20	14	4	X		89.4							
65	40	13	3	X		91.3							
66	00	15	1	X	4	93.2							
67	20	14	4	X		95.1							
68	40	13	3	X		97.0							
69	00	15	1	X	4	98.9							
70	20	14	4	X		100.8							
71	40	13	3	X		102.7							
72	00	15	1	X	4	104.6							
73	20	14	4	X		106.5							
74	40	13	3	X		108.4							
75	00	15	1	X	4	110.3							
76	20	14	4	X		112.2							
77	40	13	3	X		114.1							
78	00	15	1	X	4	116.0							
79	20	14	4	X		117.9							
80	40	13	3	X		119.8							
81	00	15	1	X	4	121.7							
82	20	14	4	X		123.6							
83	40	13	3	X		125.5							
84	00	15	1	X	4	127.4							
85	20	14	4	X		129.3							
86	40	13	3	X		131.2							
87	00	15	1	X	4	133.1							
88	20	14	4	X		135.0							
89	40	13	3	X		136.9							
90	00	15	1	X	4	138.8							
91	20	14	4	X		140.7							
92	40	13	3	X		142.6							
93	00	15	1	X	4	144.5							
94	20	14	4	X		146.4							
95	40	13	3	X		148.3							
96	00	15	1	X	4	150.2							
97	20	14	4	X		152.1							
98	40	13	3	X		154.0							
99	00	15	1	X	4	155.9							
100	20	14	4	X		157.8							

Signals Broken Off Abruptly
Pressure Ahead

Pressure Ahead

Pressure Ahead

Signals Stopped
Pressure Ahead

Signals Stopped

-113-

CONFIDENTIAL
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Processing of Rasende No 7/121

Φ	B	t°	γ	F	q°	q	$\frac{\Delta T}{B}$	T_ϕ	Θ'	F, %	W	Notes
7	1032	-32.0		83	-	-	-	-	-	-	-	
200	1005	-28.7	-1.74	82	0.3	0.2	0.5	-28.2	-29.0	-	-	
500	965	-17.7	-3.66	72	0.8	0.6	1.5	-16.2	-14.0	-	-	
900	914	-12.3	-1.35	65	1.5	1.0	2.5	-9.8	-2.9	-	183	
1000	902	-11.1	-1.20	65	1.6	1.0	2.5	-8.6	-0.7	-	-	
1500	842	-11.1	-0.00	65	1.7	1.1	2.8	-8.3	-5.0	-	-	
1660	824	-12.8	11.06	65	1.6	1.0	2.5	-10.3	-4.7	-	-	
2000	786	-13.6	0.24	65	1.5	1.0	2.5	-11.1	-7.7	-	-	
2380	748	-14.4	0.21	65	1.5	1.0	2.5	-11.9	-10.8	-	-	
2500	736	-15.2	0.36	65	1.4	0.9	2.3	-12.9	-11.0	-	189	
3000	689	-18.4	0.64	65	1.1	0.7	1.8	-16.6	-12.8	-	-	
4000	600	-27.4	0.90	65	0.5	0.3	0.8	-26.6	-12.5	-	-	
5000	519	-36.7	0.93	65	-	-	-	-	-	-	194	
6000	447	-47.2	1.05	65	-	-	-	-	-	-	-	
7000	382	-54.2	0.70	-	-	-	1000	240	-27.8	82	220	
7620	347	-56.6	0.39	-	-	-	900	1010	-11.1	65	-	
8000	327	-56.6	0.00	-	-	-	800	1870	-13.2	65	-	
9000	278	-56.6	0.00	-	-	-	700	2880	-17.6	65	224	
10000	236	-56.6	0.00	-	-	-	600	4000	-27.4	65	-	
10580	212	-56.6	0.00	-	-	-	500	5250	-39.0	65	-	
							400	6720	-52.4	-	-	
							300	8530	-56.6	-	-	

Key:

 Φ - Height in Dynamic Meters, (Geopotential),

B - Pressure in Millibars,

 t° - Temperature in $^\circ\text{C}$ γ - Vertical Temperature Gradient

F - Relative Humidity in Percents

 q° - Specific Humidity for the Saturated State (Taken From Diagrams)

q - Specific Humidity Corresponding to Relative Humidity in Column F

W - Vertical Speed of Ascent in Meters Per Minute

B - Main Isobaric Surfaces

 Φ' - Dynamic Meters for These Surfaces t° - Temperature at Heights Corresponding to Main Isobaric Surfaces

F, % - Relative Humidity for the Same Heights

Processed By Gudovana Checked By Makhotin 29/V/1944

CONFIDENTIAL

CONFIDENTIAL

- 114 -

CONFIDENTIAL

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Chapter IV. Preprocessing ^{Radioonde} ~~Rasende~~ Signals

The following materials are necessary for processing of ^{radioonde signals} ~~rasende signals~~:

1) a reception blank and calibration charts ^{for} of the pressure, temperature, and humidity elements;

2) the collection "Tables and Nemeograms" (3), henceforth referred to as the Symposium for the sake of brevity;

3) ² a ^P psychometric table, together with a table for converting millimeters of pressure into millibars;

4) psychometric tables;

5) aerological codes;

6) a logarithmic ruler;

7) affix. books;

8) a comptometer;

9) French curves for constructing pressure curves.

It has been found efficient to process ^{radioonde} ~~rasende~~ signals in the following

order:

1. Finish filling in the front of the signal reception blank. Some of the columns ^{must} be filled in before launching. The remaining columns ~~must~~ be filled out before reception ends.

2. Analyze the signals received.

In signal reception, the numbers of the sections and the numbers of the teeth on the pressure comb must be set down in order, and the duration of pressure signals and the moments when the pressure arm is on the middle of a tooth (middle moments) must be calculated.

Before ^{analyzing} ~~starting the analysis~~ of the ^{signals} ~~signals~~, the ~~correctness of the sec-~~ c tion numbers and the pressure teeth numbers should be ^{checked} again, using the duration of the signals received from these teeth and the control signals

CONFIDENTIAL

CONFIDENTIAL

-115-

CONFIDENTIAL

CONFIDENTIAL

as a guide. In the example given, the temperature contact arm was resting upon the 2nd tooth in the 15th section at a distance of 0.3 from its beginning, i.e., 15/2 (0.3) during the ground check in air.

One long signal (sadaash) was heard at the time of launching. ^{Com-}~~Com-~~parison of the temperature in the ground check (-32.7°) and the temperature before launching (-32.0) shows that the temperature has increased by 0.7°.

The sensitivity of the temperature element according to the calibration chart (Fig. 79) is 1.48° per tooth, i.e., a temperature increase of 0.7° should correspond to a displacement of the contact arm upwards along the comb of approximately 0.5 teeth. Since the contact arm was 0.3 from the beginning of the 2nd tooth of the 15th section, a ^{displacement} ~~displacement~~ upwards of 0.5 would move it to the 1st tooth of the 15th section. This is why one dash, and not two, was heard at the time of launching. Thus, the number of the section and the number of ~~the~~ tooth must be correct.

The pressure ^{contact} ~~contact~~ arm was resting on tooth 3s (0.2) during the ground check in air. Consequently, the pressure signals should be heard immediately after launching, which is noted in column "B" by a cross (for ^{the} ~~a~~ time 00 minutes, 00 seconds).

The section numbers of the temperature signals are also checked ^{with} ~~by~~ the sequence of temperature control signals by comparing ^{these numbers} ~~them~~ with the position of control teeth on the comb diagram drawn in at the ^{top} ~~top~~ of the reception blank.

The numbers of the pressure teeth are checked by the duration of signals. In addition, as shown in Table 12, at 34 minutes, 50 seconds, the control pressure signal (xxx) was heard. Consequently, the pressure signals before it belong to the 9th tooth, and after it, to the 10th tooth, ~~which corresponds to order of the numbers according to duration.~~

CONFIDENTIAL

CONFIDENTIAL

- 116 -

CONFIDENTIAL

CONFIDENTIAL

3. Calculate the temperatures from the ^{Teeth} on the temperature comb.

If the temperature element has curvilinear sensitivity, the ~~results of~~ ^{Calibration chart is} checking are shown in the form of a graph (Fig. 78), the abscissa being the teeth of the temperature comb (5 millimeters per tooth), and the ordinate, the temperature (1 millimeters equals 0.2° or 5 millimeters equals 1°). The curve is broken up into sections (the points of inflection are usually encircled), with the sensitivity coefficient corresponding to a given section written opposite it.

Before analysis of the comb ^{according} with ~~respect~~ to the diagram ^{at} the upper ^{Top} part of the reception, ^{blank} find the section and tooth upon which the temperature contact arm was resting during ^(ground check) exposure in air, and note the position of the contact arm (tenths of a tooth) by a vertical ink mark, and write down the temperature of the ground check opposite this mark. In the example given (Table 12), the mark is made on the 2nd teeth of the 15th section 0.3 from its beginning and the temperature -32.7° is written opposite it.

Then the sections (and teeth) which the temperature contact arm has reached ⁱⁿ its movement up and down the comb, ~~if there was a temperature in version,~~ is observed. In the example, the lowest position of the contact arm was 18/3 (at 39 minutes, 60 seconds), and the highest was 12/1 (the control K at 5 minutes, 60 seconds). The section of the comb between 18/3 and 12/1 is then divided into parts in which the sensitivity ^{coefficient} ~~coefficient~~ remains constant. The parts should be divided with an accuracy of one tooth.

In the example, the point of inflection of the curve lies at ^{14/1} (0.3), and we ^{consider} ~~consider~~ that the 4th tooth of the 13th section is the end of one part. Had the point of inflection been ~~situated~~ at 14/1 (0.5) or 14/1 (0.6), ~~the the~~ end of the 1st teeth of the 14th section would have been considered the end of a part. We determine the other boundary of the part with a sensitivity coefficient of 1.62° in the same ^{way} ~~way~~, and find that it ^{lies on} ~~falls on~~ the beginning of the ^{4th} ~~4th~~ tooth of the 7th section. A vertical mark is made on the ^{comb} ~~comb~~

CONFIDENTIAL

CONFIDENTIAL

-117-

CONFIDENTIAL

CONFIDENTIAL

4th
 diagram opposite the end of the 4th tooth of the 13th section (below it), to the right of which the sensitivity coefficient is 1.66° and to the left, 1.88° .

After this is done, analysis of the comb, i.e., the search for the temperature values corresponding to the transitions from one tooth to the next, ^{can} may be begun. The analysis is made in the following way: the position of the contact arm $15/2$ (0.3) corresponds to a temperature of -32.7 . The sensitivity coefficient for this part is 1.88° , and therefore the temperature must change by $1.88 \times 0.7 = 1.32$ by the end of the 2nd tooth. Consequently, the transition to the 3rd tooth must correspond to a temperature of $-32.7 - 1.32 = -34.02$, which is noted on the diagram at the transition from the 2nd to the 3rd tooth.

Then 1.88° is subtracted from the temperature -34.02 and we obtain the temperature -35.90° , which corresponds to the transition from the 3rd to the 4th tooth, etc. ^{The comb is calculated} ~~The comb is calculated~~ in the same way for increasing temperature, except that the temperature ^{is} is increased by the sensitivity ^{cor} corresponding to the given part. In the example given, the 2nd tooth of the 15th section will correspond to a temperature of $(-32.7) + (0.3 \times 1.88) = -32.14 + 0.564 = -32.14 + 0.564 = -31.576$. Further, $-32.14 + 0.564 = -31.576$, which corresponds to the transition from the 1st tooth of the 15th section to the 4th tooth of the 14th section. This calculation is continued up to the 13th section, where a new ^{sensitivity} ~~sensitivity~~ of 1.66° per tooth is added.

All calculations are made accurate to 0.01° , and then rounded off to 0.1° . Calculation of the comb should be checked in the following manner. The number of degrees corresponding to a 10-tooth displacement of the comb is subtracted from the temperature for the first transition (-34.0° in the example). The temperature obtained should be found on the comb, ~~otherwise if~~ ^{calculation} ~~the computation~~ of the comb is correct. In the example, we have $-34.0^\circ - (1.88^\circ \times 10) = -34.0^\circ - 18.8^\circ = -52.8^\circ$. This temperature corresponds to the transition to the 1st tooth of the 18th section and thus the ^{calculation} ~~computation~~

CONFIDENTIAL

CONFIDENTIAL

- 118 -

CONFIDENTIAL

CONFIDENTIAL

of the comb was correct. The ^(calculation) computation is checked in the same way for increasing temperatures. If ~~there are~~ ^{less} less than 10 teeth ~~of~~ a part with a given coefficient of sensitivity, the temperature change should be calculated for the number of teeth available.

When the sensitivity is rectilinear, the computation of the comb is simplified. Calculation of the comb can be done rapidly and conveniently on an adding machine. After completing calculation of the comb, proceed to ~~the following~~ ^{the "t" column} on the reception blank.

4. Fill out the "t" column, writing ⁱⁿ the temperatures for the ~~moments~~ ^{times} when the signals change ~~in~~.

The ~~following things~~ ^{following} should be kept in mind in filling out this column:

1. For a ~~signal~~ ^{signal} heard at 0 minutes, 00 seconds, write the temperature before launching (and not that of the ground check) in the "t" column. In the example, this is equal to -32.0° .

2. The temperature is not ~~written down~~ ^{entered} for temperature signals which are repeated in connection with the beginning or end of pressure ^{signals}.

3. The temperature is not recorded for the first temperature signal heard after a lapse in signals, since the part of the tooth in which the contact arm is resting when the signals ^{reappear} ~~reappear~~ is not known (line 18).

4. The temperature is ^(entered) noted for the last temperature signal in reception even when this signal is ~~not~~ repeated. This exception is allowed ~~in~~ ^{because} ~~view~~ of the small temperature changes in the stratosphere. If this were not written down, it would cause ~~processing to stop~~ ^{processing to stop} (decrease the maximum height of ascent) ~~(in the majority of cases)~~ ^{most} 3 to 5 minutes before the signals actually stopped.

Example. Let us consider the temperature entries for the ~~recess~~ ^{pressure} signals of ~~recess~~ ^{pressure} No 7/121 (Table 12). The temperature -32.0° is entered for the moment 0 minutes, 00 seconds. Owing to ~~the~~ ^{the} temperature inversion, the con-

CONFIDENTIAL

CONFIDENTIAL

-117-

CONFIDENTIAL

CONFIDENTIAL

tact arm first moves in the opposite direction to the 4th tooth of the 14th section. A ^(displacement) ~~transfer~~ to the end of the 4th tooth of the 14th section corresponds to a temperature of -30.3° , which is noted in the "t" column. The temperature is not ^(entered) ~~noted~~ for the "4" signal at 4 minutes, 00 seconds, because this signal is repeated in connection with the end of the pressure signals. The temperature is not noted for the K signal at 7 minutes, 80 seconds, for the same reason. At 8 minutes, 49 seconds, the "2" signal is received, i.e., the inversion is passed, and the contact arm has again moved downward.

At 5 minutes, 60 seconds, the contact arm has moved to K, the control teeth of the 12th section, and this transition (the end of the first tooth and the beginning of the second) corresponds to a temperature of -11.1° . Next, the inversion is passed, and the contact arm again starts to move downward along the comb. At 8 minutes, 40 seconds, the "2" signal is received, i.e., the contact arm is resting on the transition from the end of the 1st tooth (K) to the beginning of the second, which corresponds to a temperature of -11.1° . Thus, the same temperature is recorded for the signals at 5 minutes, 60 seconds, and 8 minutes, 40 seconds.

After 20 minutes, 50 seconds, the signals were interrupted, which was noted by a heavy black line (_____). At 21 minutes, 40 seconds, the signals reappeared, and the "3" signal was received. However, since the true position of the contact arm on the 3rd tooth is not known, the temperature for this signal is not entered.

At 39 minutes, 60 seconds, the ^{lapse rate} ~~decrease in temperature with height~~ begins to ^{decrease} ~~slow down~~ (trepause), ^{e.g.,} for the "3" signal is received for 9 minutes and 30 seconds; at 48 minutes, 90 seconds, the contact arm begins to move in the opposite direction (the trepause inversion).

CONFIDENTIAL

CONFIDENTIAL

-120-

CONFIDENTIAL

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~~As is clear from the above,~~ the same temperature is entered (-56.6°) for the "3" signal at 39 minutes, 50 seconds, and the "2" signal at 48 minutes, 90 seconds. The temperature is ^{entered} ~~entered~~ for the "2" signal ^(which is) repeated at 53 minutes, 00 seconds on the basis of point 4 (page ¹¹⁸ ~~127~~, text).

We now consider some peculiarities encountered in ^{filling} ~~filling~~ out the "ten" column.

Case 1. Let us suppose that ^{during} ~~at the moment of~~ ascent, any two adjacent plates of the temperature comb become shorted. In this case, the lower signal with respect to the number of dots will be missing, and the higher signal will be heard instead. Let us assume that the 1st and 2nd plates are shorted. The ^{signals} ~~signals~~ of the 1st plate (single dots) will then be missing. The indication that these plates are shorted is the duration of the signals of the 2nd plate (double dots), which will last considerably longer than the neighboring plates, and the absence of the 1st plate signals in reception. In filling out the "ten" column in this case, write the temperature for the transition to the 1st teeth, instead of the 2nd, in the line of the 2nd signal. The temperature for the transition to the 2nd tooth is generally not entered, since the time when the contact arm moved to this tooth is unknown.

Case 2. The ^{resonance} ~~resonance~~ passes an inversion layer with two plates ^{shorted} ~~shorted~~.

We assume that the temperature signals in this case have the following form (Table 13) (see page 56 of reference 2 in bibliography).

Table 13 - Entry of Temperature Signals

Time		Contacts			CoTime		Contacts		
Min.	Sec.	s	n	B	Min	Sec	s	n	B
0	00	6	3	x	-	50	6	4	x
-	25	-	4	-	3	55	7	2	x
1	00	7	2	-	5	40	-	K	x
2	00	-	2	x					

CONFIDENTIAL

CONFIDENTIAL

-121-
CONFIDENTIAL

CONFIDENTIAL

Since the 1st and 2nd ^{plates} ~~teeth~~ are shorted, it is not known whether or not the contact arm touched the 2nd tooth before ^{again} returning to the 4th tooth. Therefore, the temperature ^(correcting to the change) ~~of the transition~~ from the 4th to the 1st tooth should be written in the line "1 min., 00 sec." and in the line "2 min., 50 sec.". The points for the moments "1 min., 00 sec." and "2 min., 50 sec." ~~are not connected together on the graph, and the temperature for this interval is not taken from the graph.~~

Case 3. The ^(radio sound) ~~transmission~~ reaches the ~~height~~ of the stratosphere with two plates shorted.

We assume, as before, that the 1st and 2nd plates are shorted and that the following signals are received (Table 14).

Table 14 - Entry of Temperature Signals

Time		Contacts			Time		Contacts		
Min.	Sec.	S	n	B	Min.	Sec.	S	n	B
45	00	-	4	-	47	35	-	2	x
46	50	-	3	-	49	10	-	2	x
					Signal. Signals Stop				

In this case, the temperature of the transition from the 3rd to the 2nd tooth is written in the line "47 min., 35 sec." of the "t°" column. The temperature is not generally written for the last signal (49 min., 10 sec).

Case 4. The signals of some teeth are missing because of ^{in circuit} ~~a break in~~ the circuit of the given plate. For example, let the signals of the 3rd teeth be missing; then the signals received will be of the following form.

Table 15 - Entry of Temperature Signals

Time		Contacts				Time		Contacts				t°
Min.	Sec.	S	n	B	F	Min.	Sec.	S	n	B	F	
0	00	15	1	x	-	-	75	-	1	x	-	-24.6
-	40	14	4	x	-	-	90	13	4	x	-	-22.7
1	20	-	-	x	-	2	15	-	-	x	-	-
-	50	-	K	x	-	-	40	-	2	x	-	-19.4

In this case, the temperature is not entered for the 3rd signal ~~omitted~~, but the temperature should be entered for the following signal, since the time when the contact arm moved to this tooth is known accurately. When all these points are laid out on the graph, the omitted intervals are connected by solid straight lines.

CONFIDENTIAL
CONFIDENTIAL

- 122 -
CONFIDENTIAL
CONFIDENTIAL

Radiosonde
Fig. 78. Calibration Chart of the Temperature Element of *Radiosonde* No 7/121 4
(Instrument No. 4399).

CONFIDENTIAL
CONFIDENTIAL

-123-

CONFIDENTIAL
CONFIDENTIALFig. 79. Graph of Results
of Reconnaissance No 7/121

5. Lay out the temperature values on the graph and construct the curve showing the change of temperature with time.

On millimeter paper, ^{lay out} ~~set down~~ the temperature along the ordinate ^{with} ~~in~~ the scale $0.5 \text{ cm.} = 1^\circ$ ($1 \text{ mm.} = 0.2^\circ$), and the time along the ^{axis} ~~abscissa~~ in the scale $0.5 \text{ cm.} = 1 \text{ min.}$ ($1 \text{ mm.} = 0.20 \text{ minute}$). Then ~~lay out the points~~ ^{plot the points} and connect ~~the points~~ ^{the points} with straight lines. The graph of the distribution of temperature for the example given is shown in Fig. 79.

If there is a lapse of more than two teeth in reception, the points on either side of the lapse are connected by a dotted line, and the temperature ^{levels period} taken from the graph for the heights ^{are} ~~during~~ the lapse ~~is~~ ^{are} put in parentheses and not included in the telegrams. If the signals of one or two teeth are omitted and the temperature curve is uniform, these ~~points~~ ^{points} are connected with a ^{solid line} ~~solid line~~ the same as other intervals.

The temperature curve usually has a number of breaks, called special points. The special points of a temperature curve include the beginning and end of an inversion, isotherms, the section of the curve where the ~~decrease~~ ^{lapse rate decreases} in temperature with height ~~decreases~~, the beginning of the stratosphere, the maximum height of ascent, and the height of the lower boundary of clouds. We introduce several examples of temperature curves with special points.

Case 1. A retarded temperature drop. Such a case occurred at the Bukhta Tiksi polar station on 1 July 1943 (^{Biosonde} ~~recon~~ No 1, instrument No 2); the entries are shown in Table 16.

Table 16 - Entries and Processing of Signals

Time					t°	Time					t°
Min	Sec	S	n	B		Min	Sec	S	n	B	
0	00	7	2	-	13.4	3	70	-	2	x	-
-	40	-	2	x ³	-	4	80	-	2	-	-
-	80	-	K	x	12.0	5	50	-	3	-	6.2
1	35	-	4	x	10.5	6	30	-	4	x ⁵	4.7
-	90	8	1	x	9.1	7	00	9	1	-	3.3
2	30	-	2	x	7.6	-	40	-	2	x ⁶	1.8
-	60	-	2	-	-	-	80	-	3	x	0.4

Fig. 80. Temperature Curve with Table 16

The construction of the curve is clear from Fig. 80. The section of the

CONFIDENTIAL
CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

curve ab is characterized by a ^(smaller) lower gradient, and a and b are special points.

Case 2. Repeated alternation of adjacent signals. An example of the entry of signals and their processing for this case is shown in Table 17 and Fig. 81.

Table 17 - Entry and Processing of Signals

Time					t°	Time					t°
Min.	Sec.	S	n	B		Min	Sec	S	n	B	
10	00	13	1	x ⁶	-20.5	12	50	-	3	-	-24.9
-	30	-	1	-	-	13	00	-	4	-	-24.9
-	50	-	2	-	-21.9	-	70	-	3	-	-24.9
11	00	-	2	x ⁷	-	14	00	-	4	-	-24.9
-	20	-	3	x	-23.4	-	40	14	1	-	-26.3
-	60	-	3	-	-	-	90	-	K	-	-27.8
-	80	-	4	-	-24.9	15	20	-	3	-	-29.3

Fig. 81. Temperature Curve With Table 17

The temperature curve for this case is shown in Fig. 81. In this case, the section ab is characterized by an isothermal.

Case 3. Temperature inversions. The signals are heard in reverse order in temperature inversions. Examples of the entry and processing of signals for these cases are shown in Tables 18 and 19 and ^{Fig. 82} ~~Fig. 82~~ and 83.

Table 18 - Entry and Processing of Signals (^{Radio inside} ~~Radio~~ No 1/94, Instrument No 2413, Bukhta Tiksi, 12 November 1943)

Time					t°	Time					t°
Min	Sec	S	n	B		Min	Sec	S	n	B	
0	00	13	1	x ³	-16.9	-	30	-	3	x	3 -14.1
-	80	12	4	x	-16.9	7	30	-	3	-	-
1	90	13	1	x	-16.9	-	90	-	3	x ⁶	-
2	60	-	2	-	-18.3	9	00	-	4	x	-15.5
-	90	-	1	-	-18.3	-	40	13	1	x	-16.9
3	30	12	4	-	-16.9	-	85	-	2	x	-18.3
-	90	-	3	x ⁴	-15.5	10	20	-	3	x	-19.8
4	40	-	2	x	-14.1	-	80	-	4	x	-21.3
5	00	-	2	-	-	11	00	-	4	-	-
6	10	-	2	x ⁵	-	-	-	-	-	-	-

CONFIDENTIAL

CONFIDENTIAL

-125-

CONFIDENTIAL

CONFIDENTIAL

Table 19 - Entry and Processing of Signals (^{radiosonde} ~~Assende~~ No 3/96, Instrument No 1557, Bukhta Tiksi, 23 November 1943)

Time		Contacts					t°	Time		Contacts					t°
Min	Sec	S	n	B	F		t	Min	Sec	S	n	B	F		t
0	00	16	1	x	-		-32.8	2	10	-	4	x	-		-24.8
-	20	15	4	x	-		-31.7	-	50	14	1	x	-		-26.2
-	40	-	3	x	-		-30.3	3	40	-	2	x	-		-27.6
-	80	-	2	x	-		-29.0	4	80	-	1	x	-		-27.6
-	90	-	2	-	-		-	4	55	-	1	-	-		-
1	20	-	1	-	-		-27.6	5	40	-	1	x ⁴	-		-
-	60	14	4	-	-		-26.2	-	80	-	2	x	-		-27.6
-	70 ⁿ	-	4	x ³	-		-	6	20	-	2	-	-		-
-	80	-	3	x	-		-24.8	7	00	-	3	-	-		-29.4

The following are special points on Fig. 82: points 1 and 2, the beginning and end of the isothermal; point 3, the beginning of the second isothermal; 4, the end of the second isothermal;

Fig. 82. Form of Temperature Curve for Table 18 Fig. 83. Form of Temperature Curve for Table 19

end of the third isothermal and the beginning of the section with a ^{low} ~~retarded~~ lapse rate temperature drop; and 7, the end of the section with the ^{low} ~~retarded~~ temperature drop. The following are special points on Fig. 83: 1, the beginning of the inversion; 2, the end of the inversion and the beginning of the isothermal; 3, the end of the isothermal; 4, the beginning of the second isothermal; and 5, the end of the second isothermal.

Note. In taking the data from the graph, it ^{should} ~~should be kept in mind~~ ^{remembered} that special points with identical temperatures which are less than 0.5 minute apart in time (for a normal vertical speed of the ^{radiosonde} ~~radiosonde~~ of 300-400 meters per minute) should be considered as one point ~~which is situated in the middle of the two points~~. At vertical speeds greater than 400 meters per minute, this interval (0.5 minute) is shortened, and for speeds less than 300

CONFIDENTIAL

CONFIDENTIAL

-126-

CONFIDENTIAL

CONFIDENTIAL

meters per minute, lengthened. The difference in the height of the points bounding the isothermal should not exceed 150 to 200 meters. The special points 3 and 4 on Fig. 82 and 2 and 3 on Fig. 83 are examples of such points.

Case 4. Representation of the behavior of temperature in the ^{tropopause} ~~tropopause~~ and ~~and in the~~ stratosphere. Examples of the behavior of temperature in the ^{tropo} ~~tropo~~ tropopause and stratosphere most characteristic of the Arctic are shown in Tables 20 and 21 and Figs. 84 and 85.

Table 20 - Entry and Processing of Signals (^{Radioonde} ~~Radioonde~~ No 2/124, Instrument No 2924, Bukhta Tiksi, 5 April 1944).

Time		Contacts			t°	Time		Contacts			t°
Min	Sec	S	n	B		Min	Sec	S	n	B	
24	20	19	1	x	-55.7	34	50	-	2	x	-52.8
25	00	-	2	x	-57.2	35	00	-	2	-	-
-	30	-	2	-	-	37	20	-	1	x ¹⁴	-51.3
26	50	-	2	x ¹³	-	40	20	-	1	-	-
28	00	-	1	x	-57.2	40	50	-	4	-	-49.9
29	30	-	2	x	-57.2	43	00	-	4	-	Signals Stopped

30	40	-	2	-	-	43	50	-	-	-	Undecipherable
31	30	-	1	-	-57.2	-	-	-	-	-	Signals of
32	20	18	K	x	-55.7	-	-	-	-	-	Descent
33	00	-	3	x	-54.3	-	-	-	-	-	-

Table 21 - Entry and Processing of Signals (^{Radioonde} ~~Radioonde~~ No 10/18, Instrument No 1002, Bukhta Tiksi, 20 July 1943)

Time		Contacts				t°	Time		Contacts				t°
Min	Sec	S	n	B	F		Min	Sec	S	n	B	F	
27	50	-	4	-	-	-43.4	38	00	-	2	-	-	-41.8
-	60	-	4	x ¹²	-	-	39	00	-	2	x ¹⁴	-	-
29	00	16	1	x	-	-45.0	41	10	-	2	-	-	-
30	50	-	2	x	-	-46.6	44	60	-	2	x ¹⁵	-	-
-	80	-	1	x	-	-46.6	47	30	-	2	x	-	-41.8
32	50	-	1	-	-	-	Whistle Retation with in- Retarded						
33	40	-	4	-	-	-45.0	turrup-						
36	10	-	3	x	-	-43.4 ⁸	48	00	-	-	-	-	tions

CONFIDENTIAL

CONFIDENTIAL

-127-

CONFIDENTIAL

CONFIDENTIAL

Fig. 84. Form of the Temperature Curve For Table 20

Fig. 85. Form of the Temperature Curve For Table 21

If the boundary points of the isothermal, for example the points 1 and 2 on Fig. 85, are less than 0.5 minute apart in time, ^{the} special point should be taken ³⁵ in the middle of the section between these points.

Case 5. The beginning of an inversion or the end of an isothermal has been omitted. This case is shown in Table 22 and in Fig. 86.

Table 22 - Entry and Processing of Signals (^{Radiosonde} ~~Reconnaissance~~ No 6/103, Instrument No 978, Bukhta Tiksi, 28 December 1943)

Time		Contacts			t°	Time		Contacts			t°
Min	Sec	S	n	B		Min	Sec	S	n	B	
0	00	15	2	-	-37.0	5	60	-	3	x	-
-	20	-	3	x ³	-37.7	8	60	-	K	x	-30.7
-	60	-	2	x	-37.7	9	30	-	3	x	-30.7
1	50	14	3	x	-	10	50	-	3	-	-
2	70	-	K	x	-30.7	11	20	-	4	-	-32.5
3	80	-	1	-	-29.0	11	50	-	4	x ⁶	-
4	10	-	1	x	-	12	30	15	1	x	-34.2
4	60	-	K	x	-29.0						

Fig. 86. Form of Temperature Curve for Omission of Beginning of Inversion or End of Isothermal.

The points a and b, and also the points c and d are not connected, and the data for the heights included between these points is not taken down. The first two points are not connected because it is not known when the isothermal ended, and the inversion began. If, in this case, there had been but one point, confirming the beginning of the inversion, the point b could have been connected with a by a dotted line, given a substantial lapse (more than two teeth). The temperature data would have been taken down and put in parentheses, but would not have been sent in telegrams. If the lapse was slight (less than two teeth), the points could have been connected by a solid line. The points c and d are not connected because it is not known where the isothermal ended (2, c⁶). Points 1, 2, and 3 would be special points in this case.

CONFIDENTIAL

CONFIDENTIAL

-128-

CONFIDENTIAL

CONFIDENTIAL

61 Processing of Humidity Signals.

3. ~~Processing~~ ^{by} of humidity signals consists of finding the values of relative humidity corresponding to the ^{times} ~~moments~~ when the signals change, i.e., the ^{times} ~~moments~~ when the contact arm is ^{moving} ~~moving~~ from one tooth of the humidity comb to another. The following steps should be taken in processing humidity signals:

2. Find the correction for the displacement of the humidity comb. ^{This involves finding} ~~Subtract the location of~~ the value of relative humidity corresponding to the position of the contact arm for ^(ground) ~~ground~~ check in air on the calibration chart for the humidity element (Fig. 87) and subtraction of it from the value of relative humidity ^(determined) ~~determined~~ from the hygrometer (or from the psychrometric tables, if a reading was also taken from a wet thermometer).

In the example given, the contact arm was resting on the 4th tooth 0.8 from its beginning. This position according to the calibration chart corresponds to a relative humidity of 70%. On the graph, the values of relative humidity are placed along the ordinate ^{with} ~~in the~~ scale of 1 mm=1%, while along the abscissa are the teeth

Fig. 87. Calibration Chart of the comb in the actual width, i.e., from 1 through Humidity Element 6, 2 millimeters each, and from 7 to 10, 3 millimeters of ~~Recesses~~ ^{Recesses} No 7/121 (Instrument 4399). each.

In the example, the relative humidity according ^{to} ~~to~~ the hygrometer before ~~launching~~ ^{is equal to} 83%. Subtracting 70% from this value, we obtain the correction of -13%. This correction is ^{entered} ~~entered~~ on the front of

CONFIDENTIAL

CONFIDENTIAL

-129-

CONFIDENTIAL

CONFIDENTIAL

the blank and in the upper part of the "F, %" column and ^{thenceforth} ~~from there on~~ introduced in all values of relative humidity taken from the calibration chart.

6. For the time 0 minutes, 00 seconds in the "F, %" column, enter the relative humidity observed at the time of launching (noted on the front of the blank). In the example, this is 83%.

7. Next, the values of relative humidity must be found for the times of change of all remaining signals. In the example, the 5th signal was received at 1 minute, 80 seconds. According to the calibration chart, the beginning of the 5th tooth corresponds to a relative humidity of 69%. Adding 13%, we obtain 82%, which is entered in the "F, %" column in the line containing the ~~inscription~~ of the "5" signal.

At 2 minutes, 60 seconds, the 6th signal was received, ^{corresponding} ~~corresponding~~ to a relative humidity of 73%. At 3 minutes, 00 seconds, the 7th signal was received, corresponding to a relative humidity of 65%.

From this point on, the humidity contact arm rests on the 7th tooth, and the signals are therefore repeated. The values of humidity are not entered for the repeated signals, with the exception of the last signal in reception, ^{whose corresponding} ~~the value of humidity found for which~~ must be ^{entered} ~~repeated~~ (in the example, 65% at 34 minutes, 50 seconds).

8. If the signals change in the ^{reverse} ~~inverse~~ order, the humidity is taken from the calibration chart for the end of the tooth instead of for the beginning. For example

9. Construct the curve for the change of relative humidity with time.

On the same sheet of millimeter paper used for the temperature curve (Fig. 79), ^{lay} ~~lay~~ out the relative humidity in the scale 1 mm = 1% along the ordinate, and use the ~~pre-existing~~ time scale along the abscissa. The points laid out ^{are} ~~are~~ and encircled by squares and connected by ^{fine} ~~fine~~ straight lines.

CONFIDENTIAL

CONFIDENTIAL

- 130 -

CONFIDENTIAL
CONFIDENTIAL

8. Processing the Pressure Signals.

~~Processing of the pressure signals~~ ^(when properly processed) makes it possible to determine the height of the ^(radiosonde) ~~resende~~ at any moment and ^{give} ~~determine~~ the distribution of pressure with height.

In processing, ~~first of all~~ the calibration chart of the pressure element (Fig. 88) and the table of ordinates of comb teeth (Tables 17 and 18 of the Symposium) are used. From the latter, the distance from the beginning of the comb to the middle, beginning, or end of the teeth whose signals await processing is found (the so-called ordinates are found). Having made the proper corrections in these ordinates, the values of pressure corresponding to them are taken from the calibration chart. The heights are found according to the pressure from the hypsometric table. Then a graph is constructed of the change of height with time and the change of pressure with height (Fig. 79). The height at which the ^{radiosonde} ~~resende~~ was located at any ^{moment} ~~moment~~ of ascent and the values of temperature, pressure, and humidity corresponding to this height can be determined by using ^{this} ~~these~~ graphs.

Before we discuss finding the ordinates, we ~~can~~ will consider in more detail the construction of the calibration chart for the pressure ^{element} ~~receiver~~. (Fig. 88).

The sensitivity of the pressure element (the Bourdon tube) depends upon the elasticity of the material, the angle of bend, the dimensions of the tube, the degree of vacuum, etc. Therefore, different elements will cause different displacements of the pointer connected with them for an identical change in atmospheric pressure. Consequently, in order to know what value of atmospheric pressure corresponds to any position of the contact arm on the comb, ^{we must have} ~~there must be~~ a calibration chart for the given element ~~available~~.

CONFIDENTIAL
CONFIDENTIAL

-131-

CONFIDENTIAL

Line of Separation

Calibration Chart of
Pressure Element of
Instrument
Rasside No 4399

Line of Separation
(*Radioonde*)
Fig. 88. Calibration Chart ^{for} the Pressure Element of ~~Rasside~~ No 7/121 (Instrument No 4399)

Line of Separation indicates that part 2 should be placed on top of part 1

CONFIDENTIAL

CONFIDENTIAL

- 132 -

CONFIDENTIAL

CONFIDENTIAL

The pressure element is calibrated in the Calibration Bureau (see reference 6 in bibliography) in the following way: the ^(radioactive) ~~resonance~~ is installed under the bell of a pump and various pressures are created by pumping out the air under the bell. The position of the contact arm on the comb is read for definite pressures according to the manometer. A short table is compiled, such as Table 23, and this table is used to ~~the~~ construct the calibration chart.

Table of a ^(radioactive) ~~known~~ Pressure Element at $t = 18^\circ$

P	Instrument No	Ordinate
	4399	
760	2c (0.9)	30.6
650	3c (0.9)	58.0
550	5c (0.5)	82.5
450	7s (0.1)	107.0
350	9s (0.1)	131.8
250	10s (0.9)	156.7
150	12s (0.8)	181.2
50	15s (0.1)	207.9

The pressure combs for ^(radioactive) ~~resonances~~ are produced with high precision; the width of the individual teeth and the celluloid gaps, and also their distances from the beginning of the comb, are identical in all ^(radioactive) ~~resonances~~ of a given model. Therefore, the distance from the beginning of the comb to the beginning and end of the ^{individual} ~~individual~~ metal teeth is measured once only. The table ^{drawn up} ~~compiled~~ from this measurement (Tables 17 and 18 of the Symposium) is used to find the ordinate for any tooth of the comb, i.e., the distance from the beginning of the comb to the beginning, middle, or end of any tooth.

Note. In ^{older model} ~~resonances of older models~~, the teeth width is slightly different from that shown in Tables 17 and 18 of the Symposium. If such a ^(radioactive) ~~resonance~~ is launched, the signals must be processed from a table of ^{ordinates} ~~ordinates~~ for the given ^(radioactive) ~~resonance~~ model. If such tables are not available, the ordinates must be taken directly from the calibration chart.

The calibration chart can be drawn up easily from the ^(radioactive) ~~calibration~~ calibration table (Table 23). The pressure (1 millimeter of the graph equal to

CONFIDENTIAL

CONFIDENTIAL

-133-

CONFIDENTIAL

CONFIDENTIAL

2 millimeters ~~of~~ pressure) is laid out along the ordinate on millimeter paper. The ordinates from Tables 17 and ^q18 of the Symposium are placed along the ~~a~~ abscissa. Thus, on Fig. 88, the first point corresponds to a pressure of 760 millimeters and an ordinate of 30.6 millimeters. The latter is calculated in the following manner:

When the manometer indicated 760 millimeters, the pressure contact arm rested upon 2c (0.9). As seen from the comb arrangement, 2c is situated between 2s and 3s. According to Table 17 of the Symposium, the end of 2s is 22.5 millimeters, and the beginning of 3s, 31.5 millimeters, from the beginning of the comb. Thus, the width of 2c is 9 millimeters and 0.9 of this width is 8.1 millimeters. The beginning of 2c (the end of 2s) corresponds to an ordinate of 22.5 millimeter²; consequently, 2c (0.9) corresponds to an ordinate (i.e., a distance from the beginning of the comb) of 30.6 millimeters, ^{as was written in Table 23. The} ~~value was written in Table 23.~~ The same value can be obtained from Table 18 of the Symposium.

The second point corresponds to a pressure of 650 millimeters and an ordinate of 58.0 millimeters, calculated in the same way. On the curve obtained, the beginning and end of all metal teeth are noted by vertical marks to correspond with the ordinates of their beginning and end, and the number of the corresponding tooth is written in each section. Thus, the calibration chart makes it easy to check whether the width of the teeth on the ^{comb} ~~comb~~ of any ^{radiosonde} ~~radiosonde~~ corresponds to the values given in Tables 17 and 18 of the Symposium.

Notes. 1. For greater accuracy in processing the results of ^(radiosonde) ~~radiosonde~~ ascents, the width of the teeth (and consequently, the ordinates) are ~~considered~~ ^{drawn up} to be three times their actual size ~~in the construction of the chart.~~

2. The ^{name} ~~name~~ "ordinate" is used in the discussion because it is widely used in radio sounding practice. Actually, the ordinates, i.e., the distances from the beginning of the comb to its various ^{teeth} ~~points~~, are ^{laid out} ~~set down~~ along the abscissa of the calibration curve.

CONFIDENTIAL

CONFIDENTIAL

-134-

CONFIDENTIAL

CONFIDENTIAL

The elasticity of metals depends upon temperatures and therefore the sensitivity of the pressure element will be different for different pressures. Two calibration curves are laid out so that a temperature correction can be made to the ordinates taken off in processing. One of these is laid out for a positive calibration temperature ($+18^{\circ}$ in the example given), and the other, for a negative temperature (-55°). The curves usually intersect at a point called the compensation point.

The calibration chart drawn up is cut out in a sheet (see Fig. 28) and attached to each ^{radio console} ~~radio console~~. The first heavy vertical line on the calibration chart intersecting the curves usually corresponds to an ordinate of 50 millimeters. Using this, the values of the ordinates for other points on the curve may be easily read. For example, for a pressure of 740 millimeters, the ordinate (on the positive curve) is 36.0 millimeters, for a pressure of 700 millimeters, 45.8 millimeters, etc.

The ²⁸ ~~processing~~ of pressure signals ^{by number} ~~consists of a series~~ of operations. Below, they are described in detail in the order which has been found to be efficient in practice.

9. Calculate the correction for the displacement of the pressure contact arm.

If the position of the pressure contact arm on the comb is read and the pressure corresponding to this position is found on the calibration chart, the pressure taken from the chart and corrected for temperature should coincide with the atmospheric pressure observed at the given moment if the instrument is in good condition. Conversely, if the position of the contact arm is found from the pressure observed according to the calibration chart, it should correspond with the actual position of the contact arm on the comb after a correction in the ordinate for the temperature difference. As was

CONFIDENTIAL

CONFIDENTIAL

- 135 -

CONFIDENTIAL

CONFIDENTIAL

was previously pointed out, the difference in the pressure ordinates according to the chart and to the instrument must not exceed 15 millimeters. The processing of pressure signals usually begins with finding the ~~value~~ ^{displacement} of this difference, or, as it is called, the correction for the ~~displacement~~ of the pressure contact arm.

In the line for the time 0 minutes, 00 seconds in the column "Abs. mm." of Table 12, the atmospheric ^{AS} pressure, corrected and rounded off in millimeters (774 millimeters) is entered. The temperature according to a dry thermometer, read before launching and rounded off to integral degrees (-32°) is entered in the column " t° mm. pressure". Next, take the ordinate corresponding to a pressure of 774 millimeters from the positive ~~calibration~~ ^{calibration} curve with an accuracy of 0.1 millimeter, which is equal to 27.3 millimeters. The given ~~ordinate~~ ^{radius}, however, would have this ordinate only for a temperature of $+18^{\circ}$. In the example given, it is ~~subjected to~~ ^{the} a temperature of -32° . The calibration chart shows that the ordinate increases in this section of the comb when the temperature decreases (in the transition from the positive to the negative curve). Consequently, the ~~true~~ ^{true} ordinate at $t^{\circ} = -32^{\circ}$ will be greater than the 27.3 millimeters taken for $t^{\circ} = +18^{\circ}$.

The temperature correction can be found ^{by pro} from proportions: a 73° temperature drop ($18^{\circ} + 55^{\circ} = 73^{\circ}$) corresponds to a 5.1 millimeter increase of the ordinate, and a 50° temperature drop ($18^{\circ} + 32^{\circ} = 50^{\circ}$) corresponds to an x increase of the ordinate, or $73/50 = 5.1/x$, and $x = 3.5$ millimeters. These calculations can be made quickly and accurately on a ^{slide rule} ~~calculator~~.

Thus, the true ordinate for a temperature $t^{\circ} = -32^{\circ}$ will be $27.3 + 3.5$ 30.8 millimeters. The value obtained is entered in parentheses in the "Var." column under the uncorrected ordinate (27.3). Thus, the ordinate according to the calibration chart (or the "ordinate according to calibration", as it is called) is equal to 30.8. What ^{is the} ~~of~~ ^{actual} ~~the true~~ position of

CONFIDENTIAL

CONFIDENTIAL

- 135 -

CONFIDENTIAL

CONFIDENTIAL

was previously pointed out, the difference in the pressure ordinates according to the chart and to the instrument must not exceed 15 millimeters. The processing of pressure signals usually begins with finding the ~~value~~ ^{displacement} of this difference, or, as it is called, the correction for the ~~displacement~~ of the pressure contact arm.

In the line for the time 0 minutes, 00 seconds in the column "Abs. mm." of Table 12, the atmospheric ^{is} pressure, corrected and rounded off in millimeters (774 millimeters) is entered. The temperature according to a dry thermometer, read before launching and rounded off to integral degrees (-32°) is entered in the column " t° mm. pressure". Next, take the ordinate corresponding to a pressure of 774 millimeters from the positive ^{calibra-} ~~calibra-~~ tion curve with an accuracy of 0.1 millimeter, which is equal to 27.3 millimeters. The given ^{radius} ~~radius~~, however, would have this ordinate only for a temperature of $+18^{\circ}$. In the example given, ~~it is subjected to~~ ^{the} a temperature ^{is} ~~of~~ -32° . The calibration chart shows that the ordinate increases in this section of the comb when the temperature decreases (in the transition from the positive to the negative curve). Consequently, the ^{true} ~~same~~ ordinate at $t^{\circ} = -32^{\circ}$ will be greater than the the 27.3 millimeters taken for $t^{\circ} = +18^{\circ}$.

The temperature correction can be found ^{by pro} ~~from~~ proportions: a 73° temperature drop ($18^{\circ} - 55^{\circ} = 73^{\circ}$) corresponds to a 5.1 millimeter increase of the ordinate, and a 50° temperature drop ($18^{\circ} - 32^{\circ} = 50^{\circ}$) corresponds to an x increase of the ordinate, or $73/50 = 5.1/x$, and $x = 3.5$ millimeters. These calculations can be made quickly and accurately on a ^{slide rule} ~~logarithmic ruler~~.

Thus, the true ordinate for a temperature $t^{\circ} = -32^{\circ}$ will be $27.3 + 3.5$ 30.8 millimeters. The value obtained is entered in parentheses in the "Var." column under the uncorrected ordinate (27.3). Thus, the ordinate according to the calibration chart ~~for~~ ^{is the} the "ordinate according to calibration", as it is called, ^{of} ~~is~~ equal to 30.8. What ^{actual} ~~the true~~ position of

CONFIDENTIAL

CONFIDENTIAL

- 136 -

CONFIDENTIAL

CONFIDENTIAL

the contact arm on the comb ~~has~~? The pressure contact arm rested upon 3a (0.2) during ground check in air. According to Table 1A of the Symposium, this position corresponds to an ordinate of 35.1 millimeters ~~millimeters~~ (0.2 x 10). This is the so-called "ordinate according to instrument" which must be entered in the "Ord." column. In order to find the correction for the displacement of the contact arm, the "ordinate according to the instrument" must always be subtracted from the "ordinate according to calibration". In the example given, this correction is $30.8 - 35.1 = -4.3$. The correction obtained is written in the "Ord." column and subtracted from the "ordinate according to the instrument" in calculating the ordinates for all the ~~rest of the~~ ^{pressure} teeth on the ~~pressure~~ comb to be processed.

10. Check the correctness of the calculation of the time when the pressure arm rests in the middle of teeth.

The pressure signals are processed, as was previously pointed out, for the middle of teeth, and for the beginning or end of teeth only when the signals for the beginning or end of a tooth are unreliable (see Table 12, time 4 minutes, 00 seconds), making it impossible to calculate the time when the contact arm was resting in the middle of the tooth. The "middle times" of the teeth should be calculated ^{ed} during signal reception or immediately ^{after} ~~they~~. If it is not done then, it can be done at this stage of processing. The reception blank should be inspected once more to see which teeth should be processed according to the middle, and which according to the beginning or end. If a tooth should be processed according to the beginning or end, the mark V will be seen opposite the time for the beginning or end of the tooth.

Having completed the check, start to fill in the "ordinate according to the instrument" for the pressure signals received.

CONFIDENTIAL

CONFIDENTIAL

-137-

CONFIDENTIAL

CONFIDENTIAL

11. Write down the "ordinates according to the instrument" for the teeth to be processed.

The ordinates are written down from Table 17 of the ^{Symposium} ~~Symposium~~ and entered in the "Ord." column in the line whose time is closest in time to the "middle of the tooth". In the example given, the 4th tooth is processed according to the middle, and therefore the ordinate of the middle, 61.5 millimeters, is written down; the same is ^{done} ~~done~~ for the teeth 5s, 6s, 7s, 8s, 9s, 10s, and 11s. The end of the 12s tooth was not received because the instrument had begun to drop, and therefore the tooth 12s is processed according to the beginning. The ordinate for the beginning is 174.0 mm.

12. Make the correction for the displacement of the contact arm in all "ordinates according to the instrument" (in the ^{example} ~~example~~, subtract 4.3 from all the latter, and write the corrected ordinates in the "Var." column).

13. Find the temperatures for the middle, beginning, and end moments of the pressure teeth.

The temperatures corresponding to the "middle moments" (and also to the beginning or end moments, if these are used in processing) are needed to make temperature corrections in the pressure taken from the calibration chart and in the thickness of the layers. These temperatures can be taken from the graph of the distribution of temperature with time, constructed when the temperature signals were processed (Fig. 79, II).

Thus, in the example given, the temperature is -11.1° or -11° rounded off, for the middle moment of the 4th tooth, i.e., for the ^{Time} ~~moment~~ 6 minutes, 70 seconds. This temperature is entered in the column "t°, mom. press." in the line where the ordinates for the 4th pressure tooth are written. For the middle of the 5th tooth, i.e., for the ^{Time} ~~moment~~ 10 minutes, 75 seconds, we

CONFIDENTIAL

CONFIDENTIAL

- 131 -

CONFIDENTIAL

CONFIDENTIAL

find by the same method a temperature of -13.4° or -13° , rounded off. The temperatures for all remaining teeth are calculated in the same way.

14. Calculate the average temperature of the layers.

The average temperature of the layers is necessary in order to calculate the temperature correction for the thickness of the layers. The average temperature of a given layer is considered to be the average of the temperatures at the boundaries of the given layer, taken from the "t° mom. press." column.

The average temperature is calculated to an accuracy of 0.5° . Thus, in the example given, the average temperature of the layer from the beginning of ascent to the time 6 minutes, 70 seconds is $\frac{-22 + (-11)}{2} = -21.5^{\circ}$.

For the layer between 6 minutes, 70 seconds and 10 minutes, 75 seconds, it is equal to -12.0° , for the layer between 10 minutes, 75 seconds and 15 minutes, 60 seconds, -15.0° , etc.

The average temperatures obtained are entered in the "t° mom. pressu" column between the corresponding extreme temperatures.

15. Take the pressure and its "temperature difference" from the calibration chart.

Take the value of pressure corresponding to the corrected ordinates from the "Var." column from the positive calibration curve. Thus, for the 4th tooth, the ordinate is equal to 57.2 millimeters, corresponding to a pressure of 654 millimeters taken from the calibration chart. This ordinate, however, corresponds to a pressure of 654 millimeters only at a temperature of $+18^{\circ}$ (calibration temperature). In the example, the temperature at the time 6 minutes, 70 seconds, was -11° . The chart shows that ^{for} a temperature drop (transition from the positive to the negative calibration curve), the pressure increases for the same ordinate. Consequently, the

CONFIDENTIAL

CONFIDENTIAL

- 135 -

CONFIDENTIAL**CONFIDENTIAL**

pressure corresponding to the ordinate 57.2 millimeters taken from the imaginary calibration curve for $t = -11^{\circ}$ will be slightly higher than 654 millimeters. To calculate the correction, it is necessary to know how much the pressure changes (increases in this case) throughout the calibration range for the given ordinate.

Therefore, while taking the pressure from the positive curve (654 millimeters), count the number of squares along the vertical between the positive and negative calibration curves. In the given case, this difference is 5.5 squares or 11 millimeters of pressure (to an accuracy of 1 millimeter).

This difference (11 millimeters) is entered in the " t° mm. press." column over the temperature of the middle of the given tooth (-11°), and the pressure (654 millimeters) is entered in the "Abs. mm." column. Later, the temperature correction for the pressure will be calculated from this difference. The sign of the correction must also be determined for the difference.

The sign in all cases is determined in the following way. If the pressure increases in the transition from the positive calibration curve to the imaginary curve (the curve for a temperature of -11° in this case), the pressure correction will be positive (will be added to the pressure taken from the positive curve). If the pressure drops in this transition, the correction will be negative. The sign (+ or -) determined in this way is placed under the corresponding pressure in the "Abs. mm." column.

In the case considered, the imaginary line (for -11°) lies between the calibration curves, and in transferring to it from the positive curve (-18°), the pressure increases, and the correction is therefore positive. If the temperature had been -20° and not -11° , the imaginary line would have laid to the left of the positive curve and the pressure correction would have been negative instead of positive.

CONFIDENTIAL**CONFIDENTIAL**

-140-

CONFIDENTIAL

CONFIDENTIAL

For the middle of the 5th tooth, the ordinate is equal to 72.2 millimeters and the corresponding pressure is 592 millimeters. There are 4 mm of the graph or 8 millimeters of pressure included between the positive and negative curves for the given ordinate (72.7 millimeters). In transferring from the positive curve to ~~our~~ the imaginary curve (for a temperature of -13°), the pressure increases, and the correction will therefore be positive. After having recorded the data obtained in the proper place for the 5th tooth, proceed to the processing of the 6th tooth, 7th tooth, etc.

The pressure taken from the calibration chart for the 8th tooth is equal to 418 millimeters, and the number of millimeters between the curves is equal to zero, because both curves coincide here; consequently, the correction here is zero. From this point on, the curves cross. For the 9th tooth, the pressure is equal to 344 millimeters. There is 1 millimeter of the graph, i.e., 2 millimeters of pressure between the curves. In transferrring from the positive curve to the imaginary curve (for a temperature of -46°), the pressure drops, and the correction will be negative.

After having processed all the pressure signals received, ^(as described above) proceed to the calculation of the temperature corrections.

16. Calculate the temperature corrections for the pressures taken from the calibration chart.

The temperature correction for pressure is calculated ^{by} ~~on the basis of~~ proportions, which assume the following form for the 4th tooth of our example: $73^{\circ}/11 \text{ mm} = 29^{\circ}/x$, i.e., a temperature change of 73° (the temperature range of the calibration curves) corresponds to a pressure change of 11 mm, and a temperature change of 29° ($18^{\circ} + 11^{\circ} = 29^{\circ}$) corresponds to a pressure change equal to x ; hence $x = \frac{11 \times 29}{73} = 4.4 \text{ mm} = 4 \text{ mm}$. This correction is entered in the "Abs. mm." column over the pressure 654 mm, to the

CONFIDENTIAL

CONFIDENTIAL

- 141 -

CONFIDENTIAL

CONFIDENTIAL

right of the plus (+) sign which was previously placed there. The correction can be calculated easily and accurately with the help of a ^{slide rule} ~~logarithmic table~~. The corrections for all remaining pressure signals are calculated in the same way.

17. Convert the millimeters to millibars and find the height at a temperature of 0° .

Up ~~until~~ ^{about} 1937, millimeters were usually converted into millibars from a special table, while the height at 0° was found from a hypsometric table. It was found ~~practically~~ ^{convenient} in practice to unite these two tables, which was done in the Hydrometeorological Service in 1938-1939.

V. Ye. Blagoderov, aerologist of the Bukhta Tiksi polar station, proposed a very ~~convenient~~ ^{simple} arrangement of the data of these tables (appendix 1). This united table permits rapid location of the necessary data. At the Bukhta Tiksi polar station, this table is placed on a drum (Fig. 89), which

which can be rotated to find the needed data quickly and conveniently.

The heights ^{obtained} obtained in or-

ordinary meters are usually convert-

Fig. 89. Hypsometric table and table for converting millimeters to millibars, placed on a drum (N. F. Zhirkov's photo)

ed to dynamic meters. [The four pages of examples which follow

show how the geopotential is calculated, first for a latitude ^{of} ~~of~~ 45° , and then for the latitude of Bukhta Tiksi, or $71^{\circ}35'$. The following tables are included: Table 25, A - Conversion of Heights in Meters into Dynamic Meters, and B - Table of Proportional Parts, Table 26 - Correction for Gravitational Force if it is Different From 980 Dynes, Table 27 - Correction for the Latitude to the Dynamic Heights, Table 28 - Correction for Latitude For Geopotential at Bukhta Tiksi, and Table 29 - Conversion of Heights (in Meters) to Geopotential for Bukhta Tiksi⁷.

CONFIDENTIAL

CONFIDENTIAL

-142-

CONFIDENTIAL

CONFIDENTIAL

In calculating the heights, the latter were usually found from the hypsometric table (appendix 1) in linear meters, and then converted into dynamic meters from Table 29. It is more efficient, however, to convert the entire hypsometric table into dynamic meters, using Table 29 and the table of proportional parts (Table 25). This was done at Bukhta Tiksi (Appendix 2) and thus, the height in dynamic meters can be read off and entered in the "Height at 0°" column while the millimeters are being converted to millibars. To illustrate, we give an example of using the tables of Appendix 2 to convert the pressure from millimeters to millibars and find the height at 0° in dynamic meters for the time 6 minutes, 70 seconds (1/4th tooth) of the example. The pressure 654 mm, corrected for temperature, is $654 + 4 = 658$ millimeters. From Appendix 2, we find that this pressure corresponds to 877 millibars and a height of 1157 dynamic meters, which is recorded in the "Height at 0°" column.

18. Find the thickness of the layers.

The thickness of the heights between the individual layers is found by subtracting successive heights. Thus, in the example, the thickness of the layer between the first and second entries is $1157 - (-123) = 1280$ meters. The thickness of the layer between 1157 and 1948 meters is 791 meters, etc.

19. Check the correctness of the calculation of the thickness of layers.

This must be done before proceeding to further calculations, because an error here will cause an error in all remaining calculations dealing with finding the height. The thicknesses of all layers should be totaled and the first height at 0° (at the time 0 minutes, 00 seconds) with its sign added to this sum. The sum obtained should be equal to the last height in the "Height at 0°" column. In the example given, the sum of all thicknesses is $11,108 + (-123) = 10,985$ dynamic meters. If this total does not agree with the last height, the calculations must be rechecked.

CONFIDENTIAL

CONFIDENTIAL

-143-
CONFIDENTIAL

CONFIDENTIAL

20. Find the temperature corrections for the Thickness of the layers.

The hypsometric table (Appendix 2) from which the heights entered in the "Height at 0°" column were found is computed for an average temperature of an air column of 0°. Actually, in each separate case, the average temperature is not equal to 0°, and the thicknesses of layers calculated from these heights must be corrected for the temperature difference. If the average temperature of a given layer is less than 0°, the actual thickness must be less than calculated, and vice-versa.

The correction (dH) is calculated from the formula: $dH = \frac{H \times t_{av}}{273}$ dyn. meters where H is the thickness of the layer, t_{av} is the average temperature of the layer, and 1/273 is the coefficient of expansion of gases. The correction dH can be calculated easily and conveniently on a ^{slide rule} ~~logarithmic ruler~~. Frequently the so-called triangular graph (nomogram 1 of the Symposium), constructed from the previous formula, is used to determine the correction. On the graph, the thickness of the layers is laid out along the ordinate and the corrections along the abscissa (along the "diagonal" of the triangle). The sloping lines are lines of equal average temperatures of the layers. To illustrate, we find the correction for the first layer (1280 meters) from this graph. First, we find 1,000 along the ordinate and find the point where the horizontal line crosses the sloping line, corresponding to a ~~pre~~ temperature of -21.5°. Dropping downward from the point of intersection, we ^{find} ~~find~~ the correction of 78 meters on the "diagonal" of the triangle. The correction for 280 meters, equal to 23 meters, is found in the same way. Adding these two values, we find that the correction for a layer thickness of 1280 meters ^(needed for a temperature change of 21.5°) is equal to 101 dynamic meters.

21. Determine the height of the ^{radiosonde} ~~resonde~~ over sea level for those times for which the pressure was calculated.

CONFIDENTIAL

CONFIDENTIAL

-144-

CONFIDENTIAL

CONFIDENTIAL

The height is calculated in the following way: Write the ^{height} ~~height~~ of the station over sea level in the first line of the "Height Abs." column. Then add the thickness of the first layer to this height. The result obtained is written in the "Height Abs." in the given pressure line. Next, to this height, add the thickness of the following layer and obtain the absolute height of the ~~reference~~ ^{reference} at the time 10 minutes, 75 seconds, etc.

In the example, the height of the station over sea level is 7 meters. The first height will be $7 + (1280 - 101) = 1186$ dynamic meters. The second height is $1186 + (791 - 35) = 1942$ dynamic meters, etc.

22. Check the correctness of the height calculations.

To the last absolute height over sea level (9606 dynamic meters), add successively the ~~correctness~~ ^{corrections} for the thickness of the layers with the reverse sign, i.e., if the ~~it's~~ is negative, add, and if positive, subtract. To the result obtained, add the first height at 0° with its sign (-123) and subtract the ~~height~~ ^{height} of the station over sea level. If the heights were calculated correctly, the result obtained should agree with the last height at 0° (10,985 dynamic meters, in the example).

23. Construct the curves for the change of height with time and the change of pressure with height.

The absolute height over sea level (in dynamic meters) is laid out on the a sheet of millimeter paper on which the temperature and humidity curves have been laid out (Fig. 79). The height is laid out along the ordinate (1 mm = 20 meters) and the time along the abscissa in the same scale which was previously used for the temperature and humidity curves (i.e., 0.5 cm = 1°). When laying out heights along the ordinate, it should be kept in mind that the pressure curve must frequently be extrapolated to 1,000 millibars and (depending upon the height of the station over sea level and the initial

CONFIDENTIAL

CONFIDENTIAL

-145-
CONFIDENTIAL

CONFIDENTIAL

pressure). Therefore, a space of 50 mm of paper should be left below the height of 0 kilometers above sea level.

In the example, the first point is laid out at a height of 7 meters and a time of 0 minutes, 00 seconds; the second, for a height of 1186 dynamic meters and a time of 6 minutes, 70 seconds, the third, for a height of 1942 dynamic meters and a time of 10 minutes, 75 seconds, etc. The points are ~~marked~~^{encircled} and connected by straight lines. Ordinarily, the points will lie on one straight line, but occasionally there are sharp breaks in the curve. In the latter case, one should inspect the change in the time required for a revolution of the humidity commutator, which should be entered in the "F, %" column.

If an acceleration or a retardation of rotation is noted from the time required for a revolution, the break in the curve is considered to be legitimate. If no change in the speed of rotation is observed, the point (after checking the correctness of the ^{calculation}~~calculation~~ of pressure and height for the given time) is not considered, and the graph is made from the two nearest adjacent points.

In addition, there are several points to be kept in mind in drawing up the height curve. In most cases, the time when reception ends will not coincide with the time when the contact arm is moving from a celluloid to a silver tooth (or vice-versa), i.e., the time for the last point of the height curve will be less than the time of the last temperature signal received. Thus, in the example given, the last point of the height curve belongs to the time 48 minutes, 60 seconds, while the last temperature signal was received at 53 minutes, 00 seconds. In order to determine the height of the ^{radiosonde}~~radiosonde~~ when reception ended (the so-called maximum height of ascent), the height curve must be extrapolated to the time when reception ended. By

CONFIDENTIAL

CONFIDENTIAL

-146-

CONFIDENTIAL

CONFIDENTIAL

means of a ruler lying on the last two height points, a line is extended to the time when reception of the temperature signals ended. This extrapolation is legitimate only if the following two conditions are fulfilled:

- 1) the time interval from the end of the last pressure signal to the end of reception does not exceed the time required for the contact arm to pass the celluloid gap following the pressure signal received, and
- 2) the speed of rotation of the humidity commutator indicates that the vertical speed was constant within the extrapolation interval.

In order to save millimeter paper in recording data from high ascents of sondes, part of the height curve is broken into sections (Fig. 79). Two sets of heights are noted along the ordinate and the last height point is repeated below.

The pressure (in millibars) is also ^{laid} ~~broken~~ out on the over-all graph of the ^{radiosonde} ~~sonde~~ with respect to height. The previous height scale is used (1 mm = 20 dynamic meters) and the, for pressure, 1 millimeter equals 2 millibars. The ~~points~~ ^{triangles} are drawn around the points and they are connected by a smooth curve. (If the pressure at the earth's surface is less than 1,000 millibars, the pressure curve should be extrapolated (through a smooth curve) to 1,000 millibars.

The pressure curve, as well as the height curve, is ^{broken} ~~broken~~ into sections.

24. Lay out base heights on the ^{height} ~~height~~ curve of the ^{radiosonde} ~~sonde~~.

If base observations were made on the ^{radiosonde} ~~sonde~~, the base heights obtained, added to the height ^{of} ~~at~~ the station above sea ^{level} ~~level~~ and converted into dynamic meters, should be laid out (at the same time the height calculated from the pressure is laid out) on the ^{radiosonde} ~~height~~ graph of the height of the ^{radiosonde} ~~sonde~~ with time. Squares are drawn around the points of base heights (Fig. 79).

CONFIDENTIAL

CONFIDENTIAL

-147-

CONFIDENTIAL

CONFIDENTIAL

divergence from
The agreement of the base heights with the heights calculated from the pressure should not exceed 2% of the base heights. If the divergence exceeds this tolerance, the base observations should be carefully rechecked and the height curve of the ~~pressure~~^{radiosonde} analyzed carefully in detail. If no error is found in the calculations of the height of the ~~pressure~~^{radiosonde} from the Bourdon tube, the height curve of the ~~pressure~~^{radiosonde} should not be rejected, owing to the possible inaccuracy of the base heights. If the pressure signals for some reason were not received or are doubtful, and base observations were not made, the data is rejected and not processed.

25. Take from the graph the values of pressure, temperature, and humidity for the standard levels and special points (see Appendix 3 for the accuracy in taking off the data).

The temperature, pressure, and humidity data are taken from the graphs for standard levels and for special points. For main isobaric surfaces (~~standard~~^{station} pressures), their height, ~~the~~^{and} temperature and relative humidity at this height is taken off.

The standard heights are ~~denoted~~^{recorded} in dynamic heights, the station above sea level; 200, 500, 1,000, 1,500, 2,000, 2,500, 3,000, 4,000, 5,000 dynamic meters, etc. (in steps of 1,000 to the end of reception).

The following are called special ~~points~~^{points}: the beginning and end of inversions, the beginning and end of isothermals, the beginning and end of a section of the curve with a retarded (or accelerated) lapse rate, the beginning of the stratosphere, the maximum ~~height~~^{height} of ascent, the height of the lower boundary of clouds, maxima and minima points on the humidity curve (if they are situated at some distance from the special points on the temperature curve; if the maxima and minima humidity points are situated close, i.e., 200 meters or less, from special points of the temperature curve, the special points of the temperature curve should be taken instead of the special points of the humidity curve and the necessary data taken off the graph for them).

CONFIDENTIAL
CONFIDENTIAL

- 148 -

CONFIDENTIAL

CONFIDENTIAL

The main isobaric surfaces (standard pressures) are surfaces with pressures of 1000, 900, 800, 700, 600, 500, 400, 300, 200, and 100 millibars.

The data taken from the graph is placed in the proper columns of the last page of the reception blank. The height h , the pressure B , the temperature t° , and the relative humidity $F\%$ columns should be filled in first. For this purpose, in the first line, the height of the station above sea level (7 meters), and the pressure, temperature, and humidity observed at the time of launching is entered in the B , t° , $F\%$ columns. Then 200 dynamic meters is entered in the h column and the data for this height is taken from the graph.

For this purpose, find the point corresponding to a height of 200 dynamic meters on the height curve (Fig. 79), and follow along the horizontal to the right to the point of intersection with the pressure curve. Take off the pressure (1,005 millibars) and enter in in the "B" column in the line opposite the height 200 meters. Then follow along the vertical from the point on the height curve corresponding to 200 meters to the points of intersection with the temperature and humidity curves and take off the values; for the height 200 meters, -28.7° is entered in the t° column, and 82% in the "F" column. The next standard height is 500 dynamic meters. Before this is entered in the h column, the graph should be checked to see if there are any special points whose height is between 200 and 500 dynamic meters. ~~In the example given, there are none.~~ To do this, inspect the section of the temperature curve between 200 and 500 dynamic meters to see whether there are any special points on this curve. There are none in the example given.

Then continue moving upwards until the humidity curve is found; it is noted that there is a point ~~between~~ (1 minute, 80 seconds) between the in-

CONFIDENTIAL

CONFIDENTIAL

-145-

CONFIDENTIAL

CONFIDENTIAL

dictated points in which there is a break in the humidity curve (the humidity decreases). Had this point been close to a special point on the temperature curve, the data for this point would have ~~had~~ to have been recorded. In the example, there are no special points on the temperature curve, and therefore this point on the humidity curve is not considered to be a special point, and the data for it is not taken from the graph.

The data for the height of 500 dynamic meters should then be entered; this data, taken from the graph, is $B = 965$ millibars, $t^{\circ} = -17.7^{\circ}$, and $F = 72\%$. Next the standard height of 1000 meters is written, and the necessary data for it taken from the graph. Between 1000 and 1500 dynamic meters, there are two special points: the beginning (at 5 minutes, 60 seconds) and end (at 8 minutes, 40 seconds) of an isothermal. The height of these points coincides with the standard heights of 1,000 and 1500 dynamic meters, and therefore the data for them is entered.

The next standard height is 2000 meters. However, there is a special point on the temperature curve at 1660 meters, i.e., the beginning of a section of the curve with a retarded lapse rate at 9 minutes, 30 seconds. The necessary data, therefore, is first ^{taken} ~~taken~~ for the height of 1660 meters and then for the next standard height of 2000 meters. Continuing in this fashion, record the data for all the following special points and standard heights right up to the maximum height of ascent, equal to 10,580 meters in the example given.

After the data is taken off for the standard levels and the ^{special} ~~special~~ points, the process of taking off the data for the main isobaric surfaces is begun. The pressures 1,000, 900, 800, 700, etc up to the last standard pressure available in the ascent data is written in the $\Delta T_e B$ column on the

CONFIDENTIAL

CONFIDENTIAL

-150-

CONFIDENTIAL

CONFIDENTIAL

right side of the blank. The point of intersection of the pressure curve with the vertical line corresponding to a pressure of 1,000 millibars is found; moving from this point along the horizontal to the intersection with the height curve, the height of the given surface above sea level (240 dynamic meters) is taken off. Then, moving from the point on the height curve along the vertical upwards to the intersection with the temperature and humidity curves, the values for these elements at the points of intersection is taken off ($t^{\circ} = -27.9^{\circ}$; $F = 82\%$). The same procedure is followed for the surfaces 900, 800, 700, etc., down to the last standard pressure of the given ^{radiosonde} ~~radiosonde~~. If the pressure at the earth's surface is below 1,000 millibars, the dynamic height of this ^{surface} ~~radiosonde~~ is found at the point of intersection of the extrapolated pressure curve with the axis of the ordinate. The temperature for the height found is calculated by multiplying the first (counting from the earth's surface) vertical temperature gradient (with its sign) by the number of hundreds of dynamic meters that the height of the station (also in dynamic meters) above sea level differs from the dynamic height of the 1,000 millibar surface. The temperature at the surface is increased or decreased (depending upon the sign of the first gradient) by the number of degrees obtained, and the temperatures at the height of the 1,000 millibar surface is obtained. The humidity is not calculated. After ~~having finished~~ taking the data from the graph, proceed to calculate the vertical temperature gradients.

26. Calculate the vertical temperature gradients.

The vertical temperature gradient is calculated by dividing the temperature difference for two adjacent heights taken from the graph by the difference between these heights in hundreds of dynamic meters. Thus, in the exam-

CONFIDENTIAL

CONFIDENTIAL

-151-
CONFIDENTIAL

CONFIDENTIAL

ple given, the gradient between the heights 7 and 200 dynamic meters is

The gradient between 200 ~~and~~ 400 dynamic meters is

The sign of the gradient is calculated in the following way: if the temperature decreases with height, the ^{gradient} ~~gradient~~ is positive and if it increases, the gradient is negative. The gradients are calculated with an accuracy of 0.01° per 100 meters.

27. Calculate the specific humidity.

The specific humidity for the saturated state q^0 is found from Table 25 of the Symposium according to the pressure and temperature data. To obtain the specific humidity for a given relative humidity, q^0 is multiplied by the relative humidity. The specific humidity is not calculated if the temperature is below -30° (see the first line of the example).

28. Calculate the equivalent-temperature difference and the equivalent temperature.

The equivalent-temperature difference, ΔT_e , is calculated from the formula $\Delta T_e = 2.52 q$, where 2.52 is a constant and q is the specific humidity for a given relative humidity. The equivalent-temperature difference ΔT_e can be easily found from Table 26 of the Symposium. The equivalent-temperature difference obtained with an accuracy of 0.1 grams per kilogram is entered in the " ΔT_e " column. By adding it to the temperature observed, the equivalent temperature is obtained, which is entered (with an ^{accuracy} ~~accuracy~~ of 0.1°) in the " T_e " column. In the example given, the specific humidity is not calculated for the height of 7 meters since the ~~temair~~ temperature is below -30° , and therefore ΔT_e and T_e are not calculated for this height. For the height 200 meters, we have $\Delta T_e = 2.5 \times 0.2 = 0.5^\circ$ and $T_e = -28.7^\circ + 0.5^\circ = -28.2^\circ$.

CONFIDENTIAL

CONFIDENTIAL

-152-

CONFIDENTIAL

CONFIDENTIAL

29. Calculate the potential equivalent temperature.

The potential equivalent temperature is determined from nomogram 2 of the Symposium according to the pressure and equivalent temperature T_e and entered (with an accuracy of 10) in the "6" column.

30. Calculate the vertical speed of the rasonde.

The vertical speed W of the rasonde is determined from the height curve (Fig. 79) every 10 minutes. To do this, the point of intersection of the vertical line of the graph corresponding to a time of 10 minutes, 00 seconds with the height curve and the height of this point is calculated. The difference between this height and the height of the station above sea level is divided by 10. The quotient gives the vertical speed in dynamic meters per minute, but since the speed is usually given in linear meters, the result obtained in dynamic meters per minutes is multiplied by 1.02. The vertical speed at the end of observations when the time interval is less than 10 minutes is found by dividing the difference of the levels by the number of minutes. In the example given, the height of the point for the time t equals 50 minutes is 9920 meters. The maximum height of the rasonde at 53 minutes, 00 seconds is 10,580 dynamic meters; thus $W = \frac{10,580 - 9920}{3} \times 1.02 = 224$ meters per minute. The speeds calculated are written on the graph opposite the points of intersection and also in the "4" column of the blank between the height of the upper and lower limits. After having completed all these calculations, proceed to compose the telegram.

31. Compose the ¹⁰¹⁵Telegram of ascent.

The telegram is composed according to the form and rules stated in the "Aerological Codes" (see reference 12, pp. 10-14). According to the code, 311 of the calculated data is not necessary to compose the telegram. Thus, if there isn't enough time before the ^{Telegram} is sent to process

CONFIDENTIAL

CONFIDENTIAL

-153-

CONFIDENTIAL

CONFIDENTIAL

the results of the rasonde in full, the columns "B", "t", "F", "X", "q", "T", etc. ~~can~~, can be filled out before the telegram is sent with only the data for special points and several standard levels situated between the special points, if the latter are at least 2 kilometers apart (see the code). If this is done, processing must be completed immediately after sending the telegram.

The results of the ascent of rasonde No 7/121, used as an example, should be coded in the following form:

Avio, radio 89808 02478 10161
 28868 52589 67202 85307 98765
 00032 82083 03987 74082 00373
 09914 62365 01053 17824 62865
 01005 24748 64465 01011 40600
 77465 00313 60447 97265 76347
 066xx 90278 066xx 06212 066xx

The telegram should be sent to the address of the Rayon Weather Bureau (or to the ~~other~~ person ordering it, if the launching was carried out by special order).

32. Check the entire processing of the ^{radiosonde} ~~rasonde~~.

The processing of the ^{radiosonde} ~~rasonde~~ results should be checked by another person. Two types of errors are usually found, the first ~~being~~ ^{different} arithmetic ~~miscalculations~~ and the second, errors connected with the ~~varying~~ individual accuracy of taking off the data from graphs, nomograms, etc. If the individual ^{deviations} ~~variations~~ do not exceed the values indicated in Appendix 3 ^[of Aerological Codes, paragraph 3] they do not have to be corrected. All corrected data is noted by a V. The signature of the checker and the date of checking is placed at the bottom of the blank.

33. Copy the results of the ascent into the log-book.

The results of the ascent should be copied in the log-book in the form shown in Appendix 4.

CONFIDENTIAL

CONFIDENTIAL

- 154 -

CONFIDENTIAL

CONFIDENTIAL

34. Make a copy of the processing of the results of the rasende ascent.

The copy should include all data on the front of the reception blank, all ^{radiosonde} ~~rasende~~ signals, the first line of the processing of pressure signals, (for the time 0 minutes, 00 seconds), the ~~coefficients of~~ ^{completeness of} sensitivity coefficients (dt) and the regions where they apply on the temperature comb, all entries in the "t° mom. press." column, and all data in the "Pressure Abs. mm." column. By using this data, the processing of the ~~results of~~ the ^{radiosonde} ~~rasende~~ ascent can be ^{completed if} finished (when necessary) when the original (reception blank, calibration charts) is not available. The copy made in this way remains in the station's ^{records} ~~records~~.

END

CONFIDENTIAL

CONFIDENTIAL

-155-

CONFIDENTIAL

CONFIDENTIAL

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CONFIDENTIAL

CONFIDENTIAL

- 1 -

CONFIDENTIAL
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